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ABSTRACT

These hearings focused on topics and issues related to the status, quality, and improvement of K-12 science and mathematics in the Pittsburgh area. Science and mathematics teachers, school administrators, school board members, industry leaders, and college officials provided a firsthand description of the nature and direction of science and mathematics curricula as well as their perceptions of what improvements could be made in these areas. These individuals are Delores Augustine, Don McBride, William Merryman, Wayne Mikach, Albert Caretto, Jane Konrad, John DeBlasio, George Murphy, Allen Blacka, Paul LeMahieu, Shirley Joyner, and Hugh Lang. David Bergholz, James Colker, Milton Gottleib, Dan Swickline, Julius Brown, and John Sabol provided input from the perspectives of local industry and the Allegheny County Community college on what technical skills are presently needed and will be needed in the workplace, as well as insights into related areas. Lauren Resnick discussed how current research at the University of Pittsburgh's Learning Research and Development Center is beginning to provide a basis for improved education. For example, research on reading comprehension is providing guidelines for rewriting science textbooks (and other discipline textbooks) so that they are more easily understandable and easier to learn from. (JN)

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SCIENCE AND MATH EDUCATION

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HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

NINETY-EIGHTH CONGRESS

SECOND SESSION

FEBRUARY 10, 1984

[No. 128]

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SCIENCE AND MATH EDUCATION

FRIDAY, FEBRUARY 10, 1984

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY,
Pittsburgh, PA.

The subcommittee met, pursuant to notice, at 9:40 a.m., in the David L. Lawrence Convention Center, Pittsburgh, PA, Hon. Doug Walgren (chairman of the subcommittee) presiding.

Mr. WALGREN. The subcommittee will be in order. Witnesses will be coming throughout the day but we have a long list of witnesses and if we delay any longer we are going to not get through what we ought to get through with in this process.

I would like to welcome you to this hearing on elementary and secondary education, particularly the math and science interests in the Pittsburgh area.

In the Congressional process I really cannot stress enough how important it is to hear from people directly involved in education, those who are on the frontline and who deal with the problems on a day to day basis.

As parents and as citizens and as public officials we are deeply concerned with the quality of our children's education.

As we all know, the key to a bright future for anyone rests on a solid education, especially in the beginning years of elementary and secondary school.

We fear that if we do not expose our students to a good start in math and science in particular that they will be unable to catch up to those disciplines in later years because each step is based so immediately on the step that preceded it.

The focus of today's hearing is on math and science education.

On a national level we are constantly shown examples of how far ahead of us students in other countries and particularly those which we compete with are when we compare them to the level of achievement and competence of American students in math and science. It is a fact that only one-sixth of our high school students take a course in science in the 11th or 12th grades of high school. Only half of our students take a course in math in those grades.

By comparison, Japanese high school students who are college bound take 4 years of math and 3 years of science.

In the Soviet Union, high school students take 5 years of physics and 4 years of chemistry as the necessary base from which to go on to higher education. It is no wonder that the Soviet and Japanese universities graduate many more scientists and engineers than American colleges and universities.

We used to take some comfort in the fact that many of the Nobel Prizes were won by Americans and that is a fact with which we can take great pride and know that there is good in our system.

On the other hand, a great part of the reason for that is because we are a very large country and simply by numbers we are some of the brightest people and those brightest people do succeed in our system.

But even the numbers are now catching up to us. In Japan there is a greater number of engineers in certain important engineering disciplines graduating from their system. There is a greater number of Japanese engineering graduates than there are even in a society as large as the United States. These facts are important on their own, but they are especially important when you consider them in the light of the increasingly technological nature of the world economy that we are going to face in the future.

These facts are loaded with serious consequences for both our own economic growth and in the long run our national security.

In the Congress there has been a growing involvement in this issue over the last several years. The House of Representatives passed a bill known as H.R. 1310, entitled the Emergency Mathematics and Science Education Act last year. This bill is a start in trying to add some Federal encouragement and resources to this problem.

It has not yet passed the Senate. It will be under continuing discussion in the House of Representatives when a vehicle does come back from the Senate, as we hope will happen this year.

In addition, this subcommittee authorizes the National Science Foundation on a year by year basis. We are trying to encourage the National Science Foundation to get actively involved in science education which is part of their mandate.

In the last several years there has been a declining interest in that effort, from the first budgetary years of the present administration and the Science and Engineering Education Directorate was phased out.

In response to the congressional interest in that the National Science Foundation has now restarted its formal involvement in science and engineering education and we hope, through these kinds of hearings, to keep our committee as fully aware of what the needs are in the country as is possible so that we can bring the proper direction to the National Science Foundation in its effort in this area.

Today we are going to hear from people who are in charge of the classrooms; science and math teachers, school administrators and school board members, industry leaders who are concerned about the quality of the talent that they will need in the future and college officials who are involved in this on a firsthand basis.

During the afternoon session we will hear from representatives from local industry as well as the Allegheny County Community College, particularly with respect to technical skills that are presently needed and will be needed in the workplace.

As chairman of the subcommittee, I want to say how much we appreciate those witnesses who are here and those who will come through the day providing there is time.

I would like to introduce to Pittsburgh my colleague on the committee, Congressman Herb Bateman, who comes from the Norfolk, VA, area, The Tidewater area Virginia.

Mr. Bateman is a Member who has brought particular interest to the education area because before he went to law school he was a teacher in the Virginia area. He has a long history of involvement in civic concern in this area, served 15 years in the Virginia State Senate before coming to the House of Representatives.

It is a particular pleasure to have you in Pittsburgh and show you a little bit of what we are proud of in this part of the country and to try to work with you in bringing appreciation of the Congress on a national level of what is out here beyond the confines of Washington and I want to welcome you to Pittsburgh very sincerely.

[The opening statement of Mr. Walgren follows:]

OPENING STATEMENT OF REP. DOUG WALGREN
PITTSBURGH HEARING ON
SCIENCE AND MATHEMATICS EDUCATION
FEBRUARY 10, 1984

I WANT TO WELCOME THIS DISTINGUISHED GATHERING OF CITIZENS TO THIS HEARING ON ELEMENTARY AND SECONDARY EDUCATION IN PITTSBURGH AREA SCHOOLS. I CANNOT STRESS ENOUGH HOW IMPORTANT IT IS TO HEAR FROM PEOPLE DIRECTLY INVOLVED IN EDUCATION, THOSE ON "THE FRONT LINE" WHO SEE THE PROBLEMS UP CLOSE. AS A PARENT, CITIZEN, AND PUBLIC OFFICIAL, I AM DEEPLY CONCERNED WITH THE QUALITY OF OUR CHILDRENS' EDUCATION. AS WE ALL KNOW, THE KEY TO A BRIGHT FUTURE FOR ANYONE RESTS ON A SOLID EDUCATION, ESPECIALLY IN THE FORMATIVE YEARS OF ELEMENTARY AND SECONDARY SCHOOL.

THE FOCUS OF TODAY'S HEARING IS SCIENCE AND MATHEMATICS EDUCATION. WE ARE CONSTANTLY SHOWN EXAMPLES OF HOW FAR AHEAD THE STUDENTS OF OUR FOREIGN ECONOMIC COMPETITORS ARE WHEN COMPARED TO THE LEVEL OF ACHIEVEMENT AND COMPETENCE OF AMERICAN STUDENTS IN MATH AND SCIENCE. FOR INSTANCE, ONLY ONE-SIXTH OF OUR HIGH SCHOOL STUDENTS TAKE AN 11TH OR 12TH GRADE SCIENCE COURSE, AND ONLY ONE-HALF OF OUR STUDENTS TAKE A MATH COURSE IN THOSE GRADES. BY COMPARISON, JAPANESE COLLEGE-BOUND HIGH SCHOOL STUDENTS TAKE <u>FOUR</u> YEARS OF MATH AND <u>THREE</u> YARS OF SCIENCE AND SOVIET HIGH SCHOOL STUDENTS TAKE <u>FIVE</u> YEARS OF PHYSICS AND <u>FOUR</u> YEARS OF CHEMISTRY. IT IS NO WONDER THAT SOVIET AND JAPANESE UNIVERSITIES GRADUATE MANY MORE SCIENTISTS AND ENGINEERS THAN AMERICAN

COLLEGES AND UNIVERSITIES. THESE FACTS ARE IMPORTANT ON THEIR OWN BUT WHEN THEY ARE CONSIDERED IN LIGHT OF THE INCREASINGLY TECHNOLOGICAL NATURE OF THE WORLD ECONOMY OF THE FUTURE THESE FACTS ARE LOADED WITH SERIOUS CONSEQUENCES FOR OUR ECONOMIC GROWTH AND NATIONAL SECURITY.

IN RESPONSE TO THIS PROBLEM, THE HOUSE OF REPRESENTATIVES PASSED H.R. 1310, THE EMERGENCY MATHEMATICS AND SCIENCE EDUCATION ACT. THIS BILL IS A SOLID START IN THE EFFORT TO BOOST THE NUMBER OF TEACHERS AS WELL AS OFFER OPPORTUNITIES FOR TEACHER AND CURRICULUM IMPROVEMENT. THE PROGRAMS ENCOMPASSED IN H.R. 1310 COVER ALL LEVELS OF EDUCATION RANGING FROM ELEMENTARY SCHOOL TO POST-GRADUATE EDUCATION. H.R. 1310 IS THE PRODUCT OF SEVERAL YEARS OF ONGOING INTEREST OF THE SCIENCE COMMITTEE IN THE ISSUE OF SCIENCE AND MATH EDUCATION. IN COOPERATION WITH THE EDUCATION AND LABOR COMMITTEE, THE SCIENCE COMMITTEE WAS ABLE TO FORGE H.R. 1310 AND GET IT PASSED BY THE HOUSE OF REPRESENTATIVES. H.R. 1310 STILL AWAITS FULL SENATE ACTION.

TODAY WE WILL HEAR FROM THE PEOPLE WHO ARE IN CHARGE OF OUR CLASSROOMS. SCIENCE AND MATH TEACHERS, SCHOOL ADMINISTRATORS, SCHOOL BOARD MEMBERS, INDUSTRY LEADERS AND COLLEGE OFFICIALS WILL GIVE US THEIR FIRSTHAND DESCRIPTION OF THE NATURE AND DIRECTION OF SCIENCE AND MATH CURRICULUM AS WELL AS THEIR PERCEPTIONS OF WHAT IMPROVEMENTS CAN BE MADE IN THESE AREAS.

DURING THE AFTERNOON SESSION, WE WILL HEAR FROM REPRESENTATIVES OF LOCAL INDUSTRY AS WELL AS THE ALLEGHENY COUNTY COMMUNITY COLLEGE ON WHAT TECHNICAL SKILLS ARE PRESENTLY NEEDED AND WILL BE NEEDED FOR THE WORKPLACE. IN ADDITION, WE WILL HEAR THE NEWEST IDEAS IN LEARNING RESEARCH DEVELOPED AT THE UNIVERISTY OF PITTSBURGH.

I LOOK FORWARD TO LISTENING AND LEARNING FROM THE WITNESSES AT THIS HEARING. AS A MEMBER OF CONGRESS AND A MEMBER OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY THIS WILL BE A VERY EDUCATIONAL EXPERIENCE FOR ME IN SEVERAL WAYS.

Mr. BATEMAN. Thank you. It is a pleasure to be here.

Mr. WALGREN. Well, with that, let's call the first panel. It is made up of Dolores Augustine from West Allegheny School District; Don McBride from Woodland Hills School District; William Merryman from Quaker Valley School District; and Wayne Mikach from the North Hills School District.

If those folks are present, please come forward.

Let me say at the outset that written statements can be made and will be made part of the record automatically and reproduced in our hearing transcript and if you have other thoughts that you feel are useful as the day goes on that may not be directly in your testimony, please feel free to submit them to us in writing and they will then become part of the record and worked with by the staff of the committee and the other members that are not here today.

So, in terms of ground rules, we are looking for anywhere in the range of 10 minutes or however long you feel it would take to communicate what you feel is most important to us in a way that you feel most comfortable.

So let me start in the order that we called you. This panel is made up of teachers involved on the elementary level, as I understand it, and we are most interested in hearing what you would like to share with us.

Can I start with Dolores Augustine? Welcome to the committee.

STATEMENTS OF DOLORES AUGUSTINE, WEST ALLEGHENY SCHOOL DISTRICT; DON McBRIDE, WOODLAND HILLS SCHOOL DISTRICT; WILLIAM MERRYMAN, QUAKER VALLEY SCHOOL DISTRICT; AND WAYNE MIKACH, NORTH HILLS SCHOOL DISTRICT

Ms. AUGUSTINE. Good morning.

When I received your letter I read through it and took the information you wanted by looking at our school district and needs in the elementary schools.

Mr. WALGREN. Let me ask you to pull the microphone a little closer so we get as much amplification as we can.

Ms. AUGUSTINE. The science program in the West Allegheny School District presents a balance of effort, life, and physical sciences.

A modified spiral approach is used in the program, concepts moved from the concrete to the more abstract at each grade level.

This progression is also basic to the program as a whole. The program contains basic scientific concepts to be mastered. These concepts are made meaningful through thought-provoking discussion and experimentation.

This strategy allows students to develop critical thinking skills. They are challenged to predict outcomes, interpret data, and draw conclusions.

I feel that some of the strengths of our science programs, they have certain attributes where successful learning can take place.

The textbooks series we use at the elementary grade level uses good skill progression. The units are very motiviating to the children and our program provides for the needs of the gifted and talented children.

We have at our disposal a well-equipped school library with a full-time librarian to assist children in research and/or allow them to pursue their individual scientific interests.

We have good parent involvement in our science program. They sponsor a science fair each year which helps to motivate the children in the area of science.

The math program at the elementary level recognizes the need for children to have a solid foundation in basic skills. This foundation is developed through a clear and simple approach followed by ample practice and reinforcement.

Children are given the opportunity to become actively involved with manipulative materials and problem solving situations that give real meaning to mathematical ideas.

The math program is a balanced program which provides for the wide range of learning experiences children require for maximum mathematical growth and concept facts, skills and problem solving.

Some of the strengths of the math program are that the objectives are relevant to each grade level.

The curriculum emphasizes articulation through the grades.

The program provides diagnostic testing in each skill area to determine strengths and weaknesses of each student.

There are provisions made for exceptional children. The staff has provided much of the supplemental materials needed to develop the math program to the fullest. The program provides additional material in the area of problem solving.

One area stands out as a weakness in the math program. This area is in the mastery of application. Some children seem to have difficulty applying basic math concepts to everyday life situations.

In order to create an environment rich in learning experiences certain needs of educators must be addressed.

First, a teacher's prime purpose is to educate children; therefore teachers must be given time to teach.

Due to additional administrative tasks it is somewhat difficult to find time to prepare for daily lessons, create imaginative ideas for classroom use, and attend to the paperwork which accumulates during a schoolday. Actual teaching time is disrupted when staff members must attend meetings scheduled by administration.

Second, an orderly and disciplined classroom is needed to begin the process. To have order and discipline one must have respect. Teachers must take up the task of bringing respect back to the teaching profession. For this to happen teachers must have the full support of the public, media, parents, administration, and school board members.

Third, to develop all skills at the elementary level to the capacity, more time on task is needed. This will help to strengthen weak areas in the curriculum and provide more continuity in learning.

Finally, more than ever, parents too must learn to deal effectively with their children. Educators often hear the cry of frustration from parents who are unable to control the behavior of their children. Services must be made available to deal with these problems.

Mr. WALGREN. Thank you very much.

[The prepared statement of Ms. Augustine follows:]

In the past two years the West Allegheny School District has addressed several of the problems discussed in the report written by the National Commission on Excellence in Education entitled A Nation At Risk.

The report states, "The burden on teachers for maintaining discipline should be reduced through the development of firm and fair codes of student conduct . . . ". The West Allegheny School District has implemented the Assertive Discipline program. Through the successful use of this program more time is spent on instruction while less time is spent dealing with disruptive students in the classroom.

It also claims, " ... And where there should be a coherent continuum of learning, we have none, but instead an often incoherent, outdated patchwork quilt ....". The staff, developed a written curriculum during the past school year. Emphasis is on relevancy, articulation, and measurable objectives.

The report states "The time available for learning should be expanded through better classroom management and organization of the school day". The administration restructured the scheduled day at the middle and high school level. This reorganization better utilizes the teaching staff and student time in directing learning activities.

SCIENCE

West Allegheny School District

Philosophy of the Science Department

The West Allegheny Science program is a sequential and coordinated program designed to stimulate curiosity, develop scientific literacy, prepare for advanced study and promote the flexibility required to accept technological change.

The Science program offers students an opportunity to pursue and develop their own interests by means of hands on experiences and library research. It develops an awareness of the environment through observation.

Career opportunities are examined with a realistic attitude toward science. A concerted effort is made to help students learn fundamentals of science appropriate to varying abilities.

Evaluation of students is made by a variety of methods including direct observation; objective tests, both teacher-made and standardized; evaluation of assignments, projects and experiments. The effectiveness of the the program is determined by comparing the results of evaluation with the stated goals.

SCIENCE TEXTBOOK SERIES

The Elementary Science program uses the Accent on Science textbook series by Charles E. Merrill Publishing Company, copyright 1980.

Content

The Science program presents a balance of the earth, life, and physical sciences. A modified spiral approach is used throughout the program. Concepts move from the concrete to the more abstract at each grade level. This progression is also basic to the program as a whole.

The program contains basic scientific concepts to be mastered. These concepts are made meaningful through thought provoking discussion and experimentation. This strategy allows students to develop critical thinking skills. They are challenged to predict outcomes, interpret data, and draw conclusions.

STRENGTHS OF THE SCIENCE PROGRAM

The following attributes afford the elementary science program the opportunity to provide experiences where successful learning can take place.

1. The textbook series uses good skill progression. It starts with familiar concepts and moves to the more abstract.
2. The units of study are highly motivating to the children.
3. The program provides for the needs of the gifted and talented children.
4. The elementary schools have at their disposal a well equipped school library with a full time librarian to assist children in research and/or allow them to pursue their individual scientific interests.
5. Parents have involved themselves in the program. Each year the Parent-Teacher Association sponsors a science fair to motivate children in the area of science.

6. The departmentalized program at the elementary level assures that adequate time is spent in the teaching of science.

WEAKNESSES OF THE SCIENCE PROGRAM

Although the science program has a well designed curriculum there is room for improvement. Some weaknesses in the curriculum are:

1. A lack of sufficient supplemental and resource materials.
2. A need to develop critical thinking skills to the fullest capacity.
3. Although time is built into the schedule for science, more time on task would assure maximum learning.
4. In order for children to comprehend basic life skills, instructors need to utilize science resource people in the community.
5. The program does not provide remediation for the slow learner.

STUDENT ACHIEVEMENT

Student achievement in the science program is evaluated by each classroom teacher. Through discussion, testing, experimentation, and reporting instructors are able to determine a student's level of mastery of each unit of study.

The elementary program provides a sound base for building higher level skills.

MATH

West Allegheny School District

Philosopy of the Math Department

The study of math is related to the real world through the use of concrete examples and a strong emphasis on problem solving. When mathematical processes are introduced they are illustrated both theoretically and practically. Students are evaluated by testing class participation, and written work. Exceptional children are provided for through the use of supplemental materials.

The math program supports the following goals of quality education:

MATHEMATICS: Quality education should help every student acquire skills in mathematics.

ANALYTIC THINKING: Quality education should help every student develop analytic thinking skills.

SCIENCE AND TECHNOLOGY: Quality education should help every student acquire knowledge, understanding and appreciation of science.

WORK: Quality education should help every student acquire the knowledge, skills and attitudes necessary to become a self-supporting member of society.

Math Series

The elementary Math program uses the Mathematics In Our World textbook series by Addison Wesley Publishing Company, Incorporated, copyright 1981.

CONTENT

The elementary math curriculum is a program which recognizes the need for children to have a solid foundation in basic skills. This foundation is developed through a clear and simple approach followed by ample practice and reinforcement. Children are given the opportunity to become actively involved with manipulative materials in problem solving situations that give real meaning to mathematical ideas.

The math program is a balanced program which provides for the wide range of learning experiences children require for maximum mathematical growth in concepts, facts, skills, and problem solving.

STRENGTHS OF THE MATH PROGRAM

The math program at the elementary level provides a solid framework for higher level skills. The strengths of the math program are as follows:

1. Objectives are relevant to each grade level.
2. The curriculum emphasizes articulation through the grades.
3. The program provides diagnostic testing in each skill area to determine strengths and weaknesses of each student.
4. There are provisions made for exceptional children. (Enrichment for gifted and talented children and remediation for slow learners.)
5. The staff is provided with much of the supplemental materials needed to develop the math program to the fullest capacity.
6. The program provides additional material in the area of problem solving.

WEAKNESSES OF THE MATH PROGRAM

One area stands out as a weakness in the math program. This area is in the mastery of application. Some children seem to have difficulty applying basic math concepts to everyday life situations.

COMPUTER LITERACY

The school district provides for a computer literacy program at the elementary level, however, it has not yet been implemented. The course outline suggests grades k-3 will emphasize computer awareness and grades 4-5 will input data and play computer games. The program will be taught by the school librarian in scheduled computer classes.

WEAKNESSES OF THE COMPUTER LITERACY

It would be more beneficial to utilize computers in the classroom. In this situation the classroom teacher is able to use the computer as an instructional tool. The computer would be used in content subject areas for drill and practice, instructional games, and simulations.

NEEDS OF EDUCATORS IN THE ELEMENTARY CLASSROOM

In order to create an environment rich in learning experiences certain needs of educators must be addressed. First, a teachers prime purpose is to educate children. Therefore teachers must be given time to teach. Due to the additional administrative tasks it is sometimes difficult to find time to prepare for daily lessons, create imaginative ideas for classroom use, or attend to the paperwork which accumulates during a school day. Actual teaching time is disrupted when staff members must attend meetings scheduled by administration.

Second, an orderly, disciplined classroom is needed to begin the learning process. To have order and discipline one must have respect. Teachers must take up the task of bringing respect back to the teaching profession. For this to happen teachers must have the full support of the public, media, parents, administration and school board members.

Third, to develop all skills at the elementary level to the fullest capacity more time on task is needed for mastery. This would help to strengthen weak areas in the curriculum and provide more continuity in learning.

Finally, more than ever, parents too must learn to deal effectively with their children. Educators often hear the cry of frustration from parents who are unable to control the behavior of their children. Services must be made available to deal with these problems.

Mr. WALGREN. Let's go right on down the panel and hear from the others and then we will have a little opportunity to talk a little bit about some of the points you raise.

Mr. McBride.

Mr. MCBRIDE. I thank you for inviting me to offer testimony before this hearing. This is an honor and privilege for both my school district and myself.

I represent a newly formed urban/suburban school system composed of highly diverse socioeconomic but contiguous geographic areas. A strong commitment to quality education is reflected in the innovative programs in science, mathematical and computer education in Woodland Hills. As illustrated in the charts in my written testimony, our school district meets or exceeds the national norms for both science and math.

In spite of the apparent success of our system, I feel concern for several aspects of education in the United States. The factors that act to limit educational progress tend to be impacted by the national environment and not easily controlled within the confines of any single school district.

As the charts indicate, the degree to which students exceed national norms is inversely proportional to the age of the student. Also, the national norms for science and math reflect a lower level of national achievement in relation to the other subjects measured.

Some factors which may contribute to this situation include:

One. In the United States we attempt to educate all children equally. The same concepts may not all be equally relevant to all children. Perhaps some children would profit from an intensification of study in areas appropriate to that child's abilities.

Two. The science and math teachers are not prepared the same way as our foreign colleagues. An education degree requires an emphasis on methods courses.

The bulk of the courses particularly in elementary education, tend to be methodology courses. Teachers in other countries are re-

quired to have a much stronger subject background in the discipline in which they are expected to teach and the methods courses are secondary to the emphasis on the subject discipline.

Three. Do we offer sufficient rewards to attract the most talented people into the field of education?

Four. Does our system of rewards and advancement remove the best people from the classroom where they are most needed?

Five. I believe many published curriculum materials could be improved. The material presented in science textbooks for primary grades would be better conveyed through filmstrips and manipulative equipment.

The science textbooks for older children should strike a happy balance between experimental/inquiry approach and a solid source text.

In education we have done both ways. We have leaned heavily into the total experimentation to the exclusion of the textbook and then we have gone the other way and used just the textbook and I think we need to explore an avenue midway between these two approaches.

Staff training and in-service should be incorporated with innovative programs and should be funded as part of the procedure.

Six. The behavior expected of our students could be improved with President Reagan's concept of increased school discipline to ensure the safety of both our students and teachers in public schools. Only then can the most productive educational environment be achieved.

In summary, education in the United States is doing well but there is still room for improvement. A greater quantity of highly motivated and proficient teachers needs to be attracted and retained in the field of education.

Also, concerted effort to uphold curriculum standards in all levels of education and a more reasonable level of control is appropriate in our schools.

We must retain our competitive edge with our foreign friends or our children will pay a price for our inaction.

Thank you very much.

[The prepared statement of Mr. McBride follows:]

TO: COMMITTEE ON SCIENCE & TECHNOLOGY - U.S. HOUSE OF REPRESENTATIVES

FROM: DONALD J. McBRIDE - ELEMENTARY MATH AND SCIENCE REPRESENTATIVE
WOODLAND HILLS SCHOOL DISTRICT

DATE: FEBRUARY 10, 1984

Dear members of the House Subcommittee on Science, Research and Technology:

Thank you for your kind invitiation to testify as a member of the panel of witnesses before your committee of inquiry. I consider this opportunity an esteemed honor and priviledge. It is my sincere hope that my testimony will, in some small way, prove useful to your committee in their attempt to make improvements in Science and Mathematics Education.

By way of introduction, I was selected as the representative of my school district based upon my education and varied experiential background. My teaching career began in 1971 in the teaching of departmentalized elementary science in grades 4,5 and 6. In addition, my experience includes the teaching of elementary mathematics as well as both Life and Earth-Space Science in grades 7 and 8. Moreover, with the advent of microcomputers in education, I have had the opportunity to function as teacher/project coordinator of the expanding computer literacy program in the Woodland Hills School District. My background, therefore, is a product of multiple educational experiences in the fields of Science, Mathematics and Computer Technology.

The school district that I represent and upon which my testimony is founded, is a newly-formed urban / suburban district that is achieving continuity between buildings and grade levels representing greatly diverse socio-economic environments.

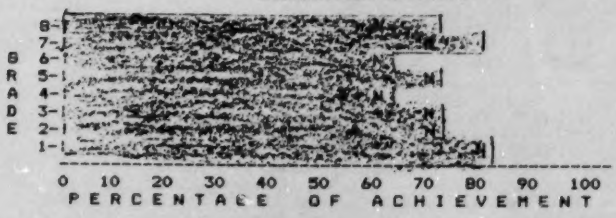
In light of the non-specific grade 1-6 Pennsylania State Guidelines (Curriculum Regulations - Statutory Authority), the Woodland Hills School District reflects a serious commitment to Science/Math Education. Science instruction, from the State Guidelines, is "Required each year....including laboratory experiences." The State requirements for Mathematics instruction are stated in a similar fashion to those for Science. No mention is made of specific time allotments, desired measureable results or specific skills / concepts to be acquired. Some consideration is appropriate to whether these guidelines are intentionally imprecise to permit the flexibility necessary for innovation by individual school districts. As the situation currently exists, the burden of determining specific curricula intensity falls upon the adiministration of individual school districts. Teachers and administrators together can determine objectives and appropriate time allocation in specific areas.

The Standardized Achievement Test (SAT) scores of the students of our school district reflect our rate of success. Enclosed are three graphs which illustrate not only the achievement of our students, but some additional results that may merit specific mention.
1.) Students of our school district meet or exceed the national norms in Science and Mathematics on all grade levels tested.

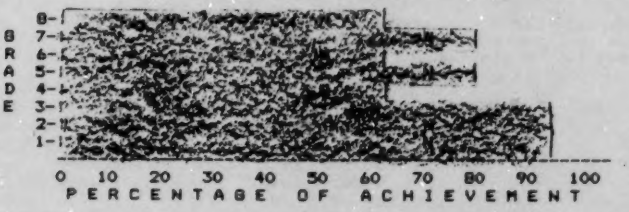
2.) The degree to which our student scores exceed the national norms decline in a progressive relation to the age of the student being tested.
3.) The national norms reflect a lower level of achievement for Mathematics and particularly for Science than for the other academic disciplines measured by this instrument.

COMPARISON OF W.H.S.D. PERFORMANCE TO NATIONAL NORMS

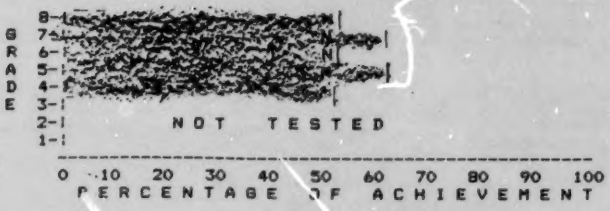
MATHEMATICS CONCEPTS



MATHEMATICS COMPUTATION



SCIENCE



Why, as outlined in item two above, does measured scholastic achievement decline with successive grade levels? In other countries, particularly those who have become very successful international competitors to the United States, a "weeding-out" process begins in about the fourth grade. Students not reflecting high academic proficiency are channeled into less scholastically oriented preparations for the work force. In the United States, however, the prevalent concept is to educate all children as equally as possible, regardless of their diverse levels of innate ability, talents and motivation. At what point do the concepts presented in our Mathematics and Science courses lose their relevancy to students destined to non-academic endeavors? Does this process contribute to the mediocrity of our educational system?

Item three illustrates that not only do our local students acquire less tangible knowledge and skills in Science than in other less technologically oriented disciplines, but the nation as a whole reflects this same phenomenon. This is not a local problem, but one of national proportions - and a very serious one in need of attention.

This committee of inquiry is obviously well aware of this crucial situation. As a teacher, I appreciate this opportunity to provide testimony on the factors contributing to this serious deficiency in the study of Math and Science in the United States.

SUGGESTIONS TO IMPROVE ASPECTS OF EDUCATION IN MATH AND SCIENCE:

TEACHER PREPARATION: It has been widely statistically reported that not only has there been a progressive decline in the standardized achievement (i.e. S.A.T.) scores of students, but also of Education Majors in our colleges and universities. Are our institutions of higher learning maintaining high standards for academic achievement or, possibly as a result of their own financial dependence upon high student enrollment, are they "adapting" their standards to ensure academic success of progressively less-scholastic students?

In addition, some consideration is appropriate of the specific coursework currently required for a degree in education. Education majors are required to successfully complete far more courses in education methodology than in the study of their specific discipline. The only possible result can be the careful preparation of a teacher who has a serious lack of command of his/her specific subject. Our international competitor countries, on the other hand, emphasize subject mastery in teacher preparation rather than the academically less demanding methodology coursework. Even after years of teaching the same course, the knowledge of the teacher is often limited to the level of the textbooks from which he has been teaching. If we were to follow the example of education in these competitor countries, we would prepare teachers to be highly knowledgeable in their academic discipline, and then to develop pedagogical skills by supervised apprentice program within the confines of the classroom.

A teacher's proficiency rating would then be a product of his ability to assimilate the skills necessary to assist his pupils to share his command of his subject matter. Currently, and regretfully, teacher ratings are representative of one's educational longevity rather than ability.

COMPENSATION: In light of the often maligned topic of teacher salaries, may I make the following personal observation? The pervasive rationale that some degree of financial compensation is necessary to attract and retain qualified and motivated people to most vocational or professional pursuits is commonly thought to be at variance with the concept of dedication in the field of Education. However, with the influx of more teachers, both male and female, providing the primary income for a family unit, providing adequate financial compensation becomes more important.

If this concept is valid for the industrial free marketplace which overtly competes for qualified and valuable personnel through competitive salary programs, then perhaps a closer examination of eduation salaries is appropriate. Are we proposing that the level of social consciousness in our most capable college students is sufficient to staff our nation's schools with the best available talent?

It is my contention, therefore, that unless superior college students can (1) be attracted to the field of education, (2) be sufficiently well prepared to contribute significantly to the academic prowess of their students, and (3) be encouraged to remain in the classroom where the need for such people is greatest, then our system of public education is destined to continued erosion of the quality of its product - the students.

Additionally, it is vital to point out that the skilled professional instructors so sorely needed in our classrooms must be encouraged to remain there. Our system of education is successful in the elimination of proficient, knowledgeable instructors through promotion to administrative positions or, disasterously, through attrition into the more promising fields of industry. Education currently maintains a 67% professional mortality rate. Science / Mathematics teachers, particularly those of greatest promise, obviously far exceed this already excessive statistical rate.

CURRICULUM CONTENT: Publishers of our most current Science programs need to be alerted to the dilema prevailing in our schools. The published science curricula for the primary grades that depend heavily upon the textbook approach are a sad representation. Similar content should be presented on filmstrips and supplemented with practical experimentation designed to enhance, on the child's level, the inquire approach to learning. Beware, however, the total experimental programs endured by children in the past which lacked continuity and sequence.

It is an unfortunately rare school system that successfully implements a highly enhanced curriculum designed specifically to compensate for this deficiency. Less proficient students require a less demanding curriculum which, in turn, further degrades the scholastic ability of the student. A highly destructive reciprocal cycle of educational degeneration is the inevitable result.

A wealth of materials exists in today's market which would add a needed dimension to a carefully structured and sequenced curriculum if appropriately packaged and marketed by the textbook publishers.

Regardless of the degree of experimentation and innovation implemented in the curriculum of either Mathematics or Science, some additional staff inservice training should be available for districts incorporating new programs. This service could be through the school district or local institutions of higher learning.

NEEDS AND PROBLEMS FACED DAILY IN THE CLASSROOM:

President Reagan has publicly advocated increased discipline in our schools. This move is intended to ensure the personal safety of not only the students, but also of the teachers. Were this concept to be achieved, a far more productive educational environment would be the unavoidable result.

SUMMATION:

In summary, it is my opinion that a destructive cycle of depreciation in the quality of education needs to be broken. This may be attacked through the attraction and retention of a greater quantity of highly proficient teachers, a concerted effort to uphold curriculum standards in all levels of education, and the reestablishment of a more reasonable level of control and discipline in our schools. Will this be expensive? Will it be cheaper NOT to take action?

Mr. WALGREN. Thank you very much, Mr. McBride. I appreciate that.

Mr. MERRYMAN. Good morning, Mr. Walgren and other members of the panel and guests.

As I started preparing my written statement and thinking about the things that I wanted to say in the oral presentation it almost became overwhelming to think of some of the things that I could say and some of the things that I wanted to say and some of the things that maybe I should not say. But what I tried to do is I tried to divide my comments into four areas in order to try to hit this idea of quality education that you pointed out in your statements earlier.

First of all, like the other members of the panel, I feel that one of the biggest things we have to do is have quality teachers and I will address each one of these separately as we go.

Also, I think we have to, as a nation, reemphasize education and the value of having a strong background in education for all people no matter what job or what occupation people intend to pursue.

The third thing is I think we have to look as a nation at our priorities. I think sometimes we look at other occupations or we look at other jobs and our children, in turn, feel that they are much more important than what teaching and a good education will provide.

The third thing is the time spent by educators, how that time should be best spent in the classroom.

I am going to go back and talk first about the training procedure. In order to produce children who are interested, motivated and productive, we have to attract and keep valuable teachers in the classroom. Too often our most valuable people either are accelerated and put into administrative positions or totally leave the profession because of salary, for a big reason, and I think we have to, again, look at our priorities in terms of if you want the best you have to be able to provide the opportunity for those people to remain and feel that they are doing a valuable job, not only for society but also in order to maintain their livelihood.

We have to raise the standards in our schools of education, in our colleges and in our universities. We have to make it important that not only do you have to know the technique of teaching but you must also have a background in what you are going to be teaching.

You can be the best motivator in the world, but if you don't know what you are talking about your students are going to learn that very quickly no matter what grade you are teaching.

Students are not as dumb as some people would like to think that they are. They look through that and they figure you out pretty quickly.

We also have to stress the idea of expert techniques in what we do. One of the other panelists mentioned time. Time for planning for these techniques so that you could have great ideas but if you don't really have the time to plan for them and accomplish them, they are of very little value.

Also we have to, and this is with our people who are in education now as well as those who are training, I think we have to look at classroom management techniques. We have to look at evaluation techniques and, most important, I think, is discipline.

We have to really look at the area of discipline because with our changing society at times discipline is a very difficult thing to maintain even in the school districts that we are looking at today.

We have to look at valuable in-service training for people.

We have to be able to use equipment that is now available, the computer which is a valuable tool in the classroom, but we must keep in mind that it is only a tool, it is not the complete answer to all of our problems.

I think it is a very valuable addition to what we are doing in education, but I don't think that just having a computer for every so many children is going to solve many of the large problems that we have.

We also need time to share with others. I think that was probably the thing I enjoyed most about coming today, even with all the preparation and all the anticipation.

In the back of my mind when I was to do this the big thing that really got to me was it will be worth the time because I will have a chance to share some ideas and pick up some ideas from others, and so often in teaching you don't have that time even with your fellow colleagues, you just don't have the time to sit down and really talk about the kids that we are working with.

I teach the sixth grade and I have approximately 60 kids that I meet daily for math and science and I see them for other subjects,

too, but so often students are different in one setting than they are in another.

It is very nice to have an opportunity to sit down and be able to talk with your colleagues and say, "Gee, how is so and so in your class? What kinds of things are you using to help get through to certain problems or how are you helping this student learn a little better?"

The reemphasis of the importance of education. We have to look at the basics. Here we are in the elementary program and that is where it all begins. In my written statement I compare elementary education to the building of a house and securing a solid foundation before you start building the rest of the structure.

So often we are involved in programs of enrichment and remediation and all these other programs and we don't always have the time to really solidly set firm goals and really shoot to have the students acquire those goals before they move on to something else.

An example I was reading in one of the other written statements this morning, a batch work of skills here and there often happens. Also you have the problem of students coming in from other districts, coming in from other States, being at different levels, not really being able to possibly handle the program that you are involved with.

Your students may be doing well, but you may pick up students from other areas that really do not have the ability to do as well and often you pick up students that are much farther ahead than what the students are that you are dealing with.

You must also regain the support of parents in the community. So often children come to school with bad attitudes and it may not have anything to do with the school or the teacher or education in general; it has a lot to do with just how parents perceive the school, possibly how they were taught or possibly the kind of success they are feeling now.

If they are out of work and they feel that they were not trained properly then we, of course, are attacked because it failed me, therefore it is going to fail you; that type of an idea.

So we really have to regain parent support. Not only in attitude, but also support in doing homework and doing it well, not for the sake of getting it done but for the sake of doing a quality job with it.

Also I think parents have to look at bedtime schedules, something as simple as that, as well as types of television programming they permit their children to watch.

I have students in my class who are fond of HBO. HBO is fine but not at 2 o'clock in the morning, and I think this is part of the priority things that we have to look at.

Again, parents have to support discipline in the school. They must send children with the idea that they are there to learn and they are not there to see how much trouble they can give someone while they are there, whether it be a paraprofessonal or whoever they happen to be working with, and that is not always the case.

We need to stress intrinsic motivation much more than extrinsic. So often we often feel in the classroom that the students are saying to you, "I dare you to try to teach me this. I dare you to try to make me do it."

When this occurs day after day you sometimes get to the point where you would like to say, "Well, if that is the attitude you have, then maybe what I am trying to do is not for you at this point."

As we look at priorities in our society we have to recognize the positive in education. Every time I pick up the newspaper I see negatives. There is a heck of a lot going on out here in our communities that are tremendous things that are going on but you never really hear that.

Now, I have worked on committees where we have tried public relations in our community and they work, they work beautifully, but they take a lot of time and when you start looking again at your own priorities if you are spending more time trying to tell everybody about how well you are doing and showing them the results of how well you are doing, then that means you are not spending the time on doing that good job that you are telling everybody you are doing.

So, I don't know that it is always possible for a school district itself or a teacher to really blow his or her own horn because you do have so many other priorities of your own that you are trying to work toward.

As a society we stress leisure time activities I think far more than we do education. We do have more time probably than other societies. That is probably a negative/positive for us, you might say.

I think we could channel that leisure time a little better and that also has a lot to do with the idea of priorities.

I think when we in a society feel that our athletes are more important than our educators, then I often wonder if we are not sort of turning things around a bit.

It might be necessary for us to wage a full media campaign, maybe subtly; but I think maybe a media campaign might be important.

The unions do it from time to time and it does seem to be quite beneficial, but I think it takes more than just individuals and individual school districts.

The last section has to do with time the teacher spends. I, as a teacher, would like to see more time for planning, more time for developing solid curriculum based on goals and goals that need to be met.

I would like to see more time being spent on teaching students how to learn.

I don't know that it is so important to learn, let's say, five pages of some particular piece of information. I think it is more important to learn how to learn and learn how to remember what you learn, being able to categorize and be interested.

Also I think problem solving is a very important thing that we leave out in both our math and science areas.

We need to have more time to meet with parents and students to keep them up to date on their progress, how they are doing and where they are going in their educational process.

We need more support personnel. We need people like psychologists, people who will come into the school and work with children who have problems who are in the classroom that need extra help.

We also need to look at class size. Each time I bring that up, whether it be at a meeting or whether it be just with colleagues, everyone will say to me there is no research that will tell you that a smaller class in size will produce a higher level or higher degree of education.

Well, that may be true. There may not be any written information about that. But if you work in a classroom, it does not take very long for you to know, even if you work with a scout group or a church group, the larger that group becomes the more the needs increase.

So, again, I think we need to look at a smaller class size and smaller class responsibility per teacher.

You could be the most fantastic teacher going, but if you want your students to perform as well as they can perform, you need to have at least a decent shot at being able to give them what they need.

We also need the time to help children who come from homes that are broken or have problems, to help them cope with their world around them and just the changes that are going on in their world and how rapid the changes are.

I again thank you for your invitation. I hope I have been of some value.

[The prepared statement of Mr. Merryman follows:]

The Testimony for the Hearing on Math and Science Education at the Elementary Level

Mr. William Merryman
Quaker Valley School District
400 Chestnut Road
Sewickley, PA 15143
(412) 741-3600

February 10, 1984

The steps of educating children are much like those followed in constructing a building. It is the task of the elementary program to build a solid basic foundation to support the framework that will follow.

Before the building begins, a great deal of planning and preparation is necessary. The school board and administrators, acting as the construction company, must set policy and hire the most qualified people to do the specific jobs.

A school system decides on a philosophy or plan for building. General goals of education add details to the plans. The plans must be flexible enough to allow for needed changes, but not so flexible as to change for the sake of change.

Next, the specialized workers are hired to further define goals and to work on making the job complete. In order for the school district to create the best finished products, top quality workers must be made available from teacher training programs at the college level. Entrance and graduation standards must be high. Academic excellence and know-how must be stressed.

Bright young people who could make excellent teachers must be encouraged to enter the field of education rather than other professions. Students entering the teaching profession need to feel they will be able to support themselves and their families as well as they could in some other profession. Today that is not the case. Many teachers find it necessary to work extra jobs to make more money. Often, these extra jobs drain teachers of their energy and effectiveness. Sometimes the quality of the finished product is minimized. Intelligent young people must feel the teaching profession is as important or more important than any other profession. They should not be discouraged about becoming a teacher because salaries are comparatively lower or not competitive in today's job market.

Teacher training programs must employ top quality teachers. These instructors must act as positive role models. Too often,

instructors of teacher training courses are people who have taken courses and have earned degrees, but have done little actual classroom teaching. Or, if they have had classroom experience, they have forgotten what the classroom was like. Therefore, when these people teach others, they do not set good examples.

Teacher trainees need to be given more classroom experience in the areas of affective planning, motivating, teaching, evaluating, and disciplining of students before they student teach. Students who train to teach must have a strong academic background in all subject areas. They must be able to speak and write clearly and correctly. Correct grammar is a must.

Teachers who are already employed need time to plan curriculum and lessons, share ideas with colleagues, and meet with parents and support personnel. Valuable inservice training is necessary to introduce the use of new equipment like the computer and to keep up to date with new teaching ideas and techniques.

The goals have been set and the workers have been hired. It is now time to start the building. Parents will send their children to school for they represent the raw materials. Some of the children will be more prepared to start than others. Some will have attended preschools and have learned many skills. Many children will have been taught preschool skills at home. Others will have had very few preschool experiences. Even though some children are the right age, they are not physically, emotionally, or socially ready to start school. All children should be tested prior to entering school or shortly after to evaluate their readiness. Those who are ready should start the building process. Others should receive help from subcontractors like psychologists, speech therapists, and other professionals to get them ready. It might be necessary to delay some children's formal schooling for a year or so.

When the educating process begins, it will be a cooperative effort between the children, parents, teachers, and administration. Cooperation between home and school is absolutely necessary. Parents must send their children to school with positive attitudes toward

learning. Education must be regarded as important. It must no longer take a back seat to other priorities of American society. Parents should be expected to support the rules of the school in terms of personal behavior and discipline. Parents must also be willing to accept and follow suggestions regarding their children's daily and future progress. All must work together to produce a finished product of value. Parents should help in the planning of their children's education, but the final decisions should be left to the teachers and administrators. The educational attitudes of quality and excellence need to be constantly stressed.

As the children progress through school, their skills should be regularly evaluated to determine how the building process should continue. This step-by-step, skill-by-skill approach is like the building of a house. Each basic step must be completed carefully and accurately before the next is begun. Otherwise, the finished product may not be solid and lasting. Students should work in small groups to receive help and supervision when needed. If classes are kept small enough and grouped properly, the students will experience positive situations. If basic skills are learned as students progress through school, they will be successful in all subject areas. Students who learn more slowly could be spared the frustration of trying to keep up. Students would have greater self-esteem when learning at their own rates. Fewer students would be discipline problems, dropouts, or nonproductive members of society. The students who learn more rapidly can be moved along to attain higher levels in the areas where they show added skill and interest.

With everyone working together to attain educational excellence, the framework of the building is firmly in place. Now the structure can support the skills and knowledge needed for specialized learning. Once students can show proficiency in the basic skills and subject areas, they will be able to attain higher levels of thinking and reasoning in special areas like math and science. The ability to think, dream, and plan for the future in a disciplined manner will keep United States students competitive with students in other technological countries of the world.

The remaining parts of the structure will be added in the upper elementary, junior and senior high school programs. The finished product will be strong, useful, and something for all to admire and be proud.

Mr. WALGREN. Thank you very much, Mr. Merryman, for the presentation of things that are of real concern.

Mr. MIKACH. I am from the North Hill School District, and I am a science teacher and coordinator. I would like to make a statement concerning elementary science.

No. 1, I think probably the most important thing that we improved about elementary science is that there is actually a point of time blocked out for elementary science. I would recommend something like 20 to 30 minutes on the primary level and 30 to 40 minutes on an intermediate level.

If this time is not blocked out, I have great fear that primary teachers particularly would tend to emphasize reading and mathematics because of the pressure that they feel on the emphasis of reading and math and deemphasize science.

I also have a feeling that many elementary science teachers have not received much science content in their undergraduate training, and that is another reason why unless there is a specific amount of time blocked out for elementary science, I think, it wou'd be neglected.

The second point I would like to make, I think, is a most important point and it is the great need for inservice training of science teachers any time new curriculums are to be emphasized.

In the 1960's we had a flurry of alphabet programs in elementary programs, DSS, et cetera. I think these programs would have been much more successful had the inservice training of elementary teachers and principals and administrators been more emphasized, rather than less emphasized.

The curriculum development, I think, was a model and I have a fear that we are getting away from some of the activity experiences of ESS and coming more toward book content, and I think that is a retreat from what elementary science education really needs to be.

The reason we are retreating is because there was a lack of adequate inservice training or if people were in service by colleges they came back to their local school district and the local school district did not provide the curriculum that they were in serviced on.

I think if you are going to have inservice training from the National Science Foundation that you need to have them meshed with the colleges and have a commitment to help the local school districts continually, not just over a summer science training program.

We instituted at the North Hill School District several years ago what I considered at that time to be an excellent elementary science program. We had an instructor from the university train 20 of our elementary teachers to serve as a nucleus for the rest of our staff.

The beginning of that program went well, the first year that program went well, and then all of a sudden the district dropped any commitment for futher inservice training.

The program is now 6 years old, and as I now visit some elementary science schools, I see material sitting on the shelf instead of being used. It is sitting on the shelf because these teachers don't know what to do with it. They don't have the time to do anything with it and they have not been properly inserviced on it.

Probably, I think the greatest need for improving elementary science would be to do an extension job of in-service training of present teachers. In this area we have declining student population and I don't think you are going to see many new teachers coming into elementary teaching at least in the Pittsburgh area. Therefore, the current teachers need to be trained and I think that is probably our most important and critical need.

The last thing I would like to mention is that while it may be true that at one time we were too activity oriented, I have a definite fear that we are now becoming too book oriented on science progams.

Students are not going to be allowed to experiment, observe, make estimates, actually do some science work. We are not going to have the kind of science that we really need to have that will lead students into good secondary programs.

So while we may have been too much in the area of science rather than book learning, I think if we go back to total book learning we would be making a drastic mistake and I think the only way that we are going to have activity oriented programs in elementary science is with the in-service training that I mentioned before.

Thank you very much.

[The prepared statement of Mr. Mikach follows:]

A C Y E

NORTH HILLS SCHOOL DISTRICT
206 Siebert Road
Pittsburgh, PA 15237-3799

February 6, 1984

BOARD OF EDUCATION
Raymond L. LaPorte, President
Alice F. Harvey, Vice-President
Josephine A. Dockman, Secretary

ADMINISTRATION
Dr. Joshua S. Geller
Superintendent

Honorable Doug Walgren, Chairman and to
Members of the Subcommittee on Science,
Research and Technology
2117 Federal Building
Pittsburgh, PA 15222

Dear Chairman and Members:

A good elementary science program has planned science experiences for all grade levels Kindergarten through 6. Science should be taught because it is intrinsic to the goals of the entire school experience, both in content and in basic skill development. A recommended time allotment is twenty to thirty minutes per day for Kindergarten through Third Grade, and thirty to forty minutes for grades Four through Six. If teachers are to teach science, they need to be involved in implementing and sustaining the program, most important they need to be inserviced on the curriculum plan for science in the schools. The major weakness of many elementary science programs is that the teachers did not receive adequate training either at college or at the local school district. The federal government needs to assist in inservice training for elementary teachers if they want science instruction to move off of dead center. In too many places science equipment sits in boxes on shelves because the teachers were not involved and did not receive proper training. Staff development is crucial and it costs money.

A good science program receives an annual allocation of funds. This annual allocation should be at least equivalent to other major curriculum areas. Since all students should receive instruction in the basic intellectual disciplines, science must receive its share of the educational dollar. In fact, as science is "materials centered" it may be more costly than other programs if it is to provide opportunities for children to deal with material objects - to explore - to investigate - to manipulate.

The funds for science are as important as funds for reading and mathematics. If federal funds are available for reading and mathematics programs - funds should also be available for science programs.

Sincerely,

Wayne R. Mikach

WAYNE R. MIKACH
Science Coordinator K-12
North Hills School District

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Accountability - Creativity - Trust - A Commitment To Excellence

Mr. WALGREN. Thank you very much, Mr. Mikach.

Well, that is a full plate, especially for somebody whose oldest child is 3 and therefore has not grappled with what you have grappled with and felt the real responsibility of having that next generation succeed.

I know we all realize that many of the problems that you raise are problems that are not really amenable to Federal Government reach. There is no question about that and yet the Federal Government certainly has tried to play a role and we look at our Department of Education. We spend a lot of money and we often wonder to what effect.

Your emphasis, Mr. Mikach, on observing rather than book learning in science, in particular, are there materials that are widespread in use that have less of the pure book, or abstract is what you would call it, less of the pure abstract emphasis for science?

Mr. MIKACH. Primarily that developed in the 1980's, the ESS, the SAPA and SCKH program. Those programs were very popular for about 10 years or so. And if you look at what is coming out now since the Government has quit doing any kind of curriculum work or emphasizing inservice training I think you see now that all the textbook series are coming back into being and that is what is currently being purchased.

The materials are still there and there is nothing wrong with most of that material. It needs to be taken off the shelfs and used.

Mr. WALGREN. Who is the originator of the inservice component at this point? I suppose it is a question of resource and whether or not we can get the school administrations to have the resources to work with to provide that kind of time and training for the teachers at that point.

Mr. MIKACH. It is very difficult to get the local administration to have any amount of their budget put into inservice training. The amount of money that school districts put into research oriented things, whether inservice training, is minimal and I don't think that I would fault them for that. They have other needs that they have to meet and with the amount of money that we have been getting lately it has been very difficult to provide any money for inservice training.

Mr. WALGREN. The curriculums that you see being used on the elementary level, materials would be a better description, are they largely the result of federally developed programs?

Mr. MIKACH. Most of the material-centered programs were federally developed and most of the equipment that I think you would see in elementary grade levels are the result of Federal fundings in the 1960's.

Mr. WALGREN. Would the others on the panel like to comment on the materials that are actually there in your school systems for science related education at the elementary level?

We keep seeing proposals to create new curricula and I often wonder whether it is necessary to create new curricula if we have given an effort to that in the past and there is something that has been reasonably and successfully delivered.

Mr. MERRYMAN. I think we have the cirriculum. I think it is just a matter of time and being able to have the opportunity to use, as

you say, the things that are on the shelves and the things that are suggested in some of the books that we have.

My background is in science. That was my minor. I was an elementary major and then a science major and, frankly, I work on committees from time to time, we pick new book series or materials to use and I don't think it is so much the unavailability of materials; I think often it is just not having the time when you are also concerned about teaching reading that day and teaching math that day and teaching language that day that, as you say, the teacher who looks at all these things and says, "Well, science, there you are, shelf." And it does make it difficult.

Now, in my situation I am really fond of science so for me I use science not only as a motivator but I use it as a means of teaching reading and teaching a lot of other things that you can interrelate, teaching language and so on.

The kids don't always know that, but the end product is what we are looking for. So I don't think it is a fact of not having the material. I think it is just having the time to really sit down and say how can I really integrate science as a whole working thing all day into many things besides just, OK, here is our block of science time today even though I think that is important, too.

By the time the kids get to me in sixth grade I hope that someone in fifth grade has done something to motivate and to get them interested in science, and the same in fourth grade and on down the line.

But I also hope that when they get to me in sixth grade they can read because if they can't read there are still lots of things that they have to be able to do first before they can understand some of the science concepts that we deal with.

Mr. WALGREN. Would the others like to comment on the curriculum and the materials that you have available to you?

Ms. AUGUSTINE. Well, going along with the time, in our program we have a proper departmentalized program where one teacher will teach a group of students language arts and the others will teach the sciences and I find that I have time to teach basic science skills but not to develop critical thinking, experimentation and that kind of thing during the school day.

Mr. WALGREN. Mr. McBride?

Mr. MCBRIDE. I would like to address that. I think there is a wealth of materials available. Every school is filled with many, many catalogs containing valuable science supplies that they can utilize to enhance the curriculum in schools.

The teacher does not know what to order if it was paid for. He is not funded for the inservice training that Mr. Mikach mentioned.

If the Federal Government put a more extreme emphasis on science education the way it did in the late 1950's, then that would spur the development of curriculum and would utilize the wealth of materials that are available.

A lot of science can be taught with very little materials if the education is there.

Mr. WALGREN. Well, let me ask, then, one last thought, and that is the emphasis that we do put on science education in the elementary levels.

You all come from different school districts and totally different administrations. Is it something that is given the priority from your administrations?

My conception of elementary school is largely reading and math and things like that. I guess my memory is not good enough to really remember those first years personally, but I don't know what sort of focus we have on science.

Are you given that area as a responsibility and with a mission, or is that something that we ought to be asking the educational community to ask itself?

Are we giving enough emphasis on science in the grades one through six or the grade school years?

Can you respond to that?

Mr. McBRIDE. If there is a demand for emphasis on any one subject in elementary grades it would have to be language arts. Somewhere down the line science gets scheduled between 3 o'clock and 3:30 in the afternoon. If science were renewed in its emphasis as it once was, then it would move earlier into the day and then perhaps be the recipient of Federal funding that would encourage the development of improved science progams.

Mr. WALGREN. How about the signals from whoever the powers that be in the educational community are? Do they see a role for science in the elementary level as significant?

Mr. MERRYMAN. In our district we have been involved in working a long-range plan and before we started that we set out to establish goals in each of the subject areas that we have, both on the elementary and secondary levels and science is a very important part. It is ranked in there with all the other subjects that we have. It is getting the emphasis but it is just from the, so to speak, the drawing board to practicality of getting done.

In our school, for instance, in our district 4, 5, and 6 stress science very heavily. We are given about a 40-minute period each day. But at least we are expected to schedule that much time for science each day.

In the primary grades that emphasis was not as great. We started a few years ago with SAPA.

Mr. WALGREN. What is SAPA?

Mr. MIKACH. The science and process approach, and it was funded by the government in the late 1950's and early 1960's and it was a design curriculum that emphasises doing rather than the reading of science, rather than the straight book approach.

Mr. MERRYMAN. Which is really neat, particularly for primary level children, because it is a hands-on approach. Presently I have most of the SAPA materials in my science area that I am using because people over the course of time have retired or the new people who have been brought in have not been taught how to use the materials. They have been cleared out to leave room for something else, and I am a real catchall person anyway, so I am always on the alert for anything that I could possibly use with the kids I have.

So we do provide. We provide a time. It is just actually taking that time and using it.

Mr. WALGREN. I see.

I want to recognize Mr. Bateman for the thoughts he might want to share with us.

Mr. BATEMAN. I think probably the first thought I would like to express is that I think the young people in your classrooms are obviously very well taught. I am quite impressed with each of you.

There are many specific things that I would like to get into. There are so many witnesses I am just going to ask you to comment on a general question that I think would be of concern to us as it is to me.

There are many who think that contemporary American society has over the past several years shown some decline both in terms of a work ethic as well as a learning ethic. Do you find that the children who are coming to you from the homes today and the elementary schools are reflecting perhaps a higher learning ethic that they are bringing to them from their homes and the case a few years ago; is the trend better or is there no change?

Mr. MERRYMAN. I would say the word is diverse. You have some who are coming in with great interest and great background, kids who have been in preschools and all kinds of other types of training, and then you have other children who come to school and don't even know their own names. That is a big diversity, I think.

Mr. BATEMAN. I would assume there has always been a large area of diversity but in terms of the whole student group that you are exposed to do you see any more favorable trend?

Mr. MERRYMAN. Really in looking at students, I don't think you would be fair in saying that kids are any brighter than they were or had more advantages than we had or even kids that we had maybe 5 or 10 years ago.

I mean we would be foolish in saying that that is not the case because of just the media contact alone that children have.

Students 5 years ago who had difficulty reading today have so many more advantages just because of things they can see or can experience through audiovisuals.

Mr. BATEMAN. But do they come to the classroom by and large more interested in learning, more excited about learning?

Mr. MERRYMAN. Not necessarily, no, in my view.

Mr. BATEMAN. Do any of the others have any observations?

Mr. MCBRIDE. I would think not. I think that we are faced with a severe competition with the television and that television plays an increasingly important role in the lives of these children. Their listening skills are not being developed because everything is repeated nine times. They expect a commercial in the classroom every 9 minutes.

Emphasis is not on reading in the home. They don't see the parents reading; therefore, they are not as inclined to learn from reading and I fear that aside from our professional community which has a good image of success through education that this may not be in the best trend.

Mr. BATEMAN. And you attribute much of that to the box?

Mr. MCBRIDE. A lot of it, yes, sir.

Mr. BATEMAN. I frankly share that view. I think one would have imagined that the universal availability of television as a media would have produced incredibly exciting learning opportunities for

the American people, but I am not sure that it has not been in totality a negative.

It is an interesting view from you who are still in education.

Mr. MERRYMAN. Kids have developed more of a dependency feeling, I think, more than an independent feeling. There is no investigation that "I will sit down and be entertained. Why should I read a book? That's work."

Mr. BATEMAN. I wish there were time to pursue more of these.

Mr. WALGREN. It is an interesting question.

How many hours of TV is the average person watching these days?

Mr. MCBRIDE. Seven hours and two minutes, sir.

Mr. WALGREN. Is that right? Is that a student that is watching 7 hours or is that the average person overall?

Mr. MCBRIDE. That is the average person and it is very discouraging in a classroom to have children come to school unprepared but able to relate one program after another and considering the program that is permissible on television in the eyes of children it is very disheartening.

Mr. WALGREN. And you don't know how you can keep the interest level because of the level of entertainment. Every analogy has its limitations but our children were very interested in regular books and then we got a pop-up book and these 13-month-old children will not look at a regular book now because they want the book that pops up.

How you get them back to the regular book at that point is very hard.

Well, let me thank you very much, all of you, for your contributions this morning. We appreciate it very much and hope that by gathering these kinds of thoughts that it will keep our focus in Washington at least responsive and in the right direction, and we appreciate your participation in this process.

Mr. MCBRIDE. Thank you for your invitation.

Mr. WALGREN. May I have Dr. Albert A. Caretto, Director of the Pennsylvania Governor's School for the Sciences; Mrs. Jane Konrad, Pittsburgh Regional Center for Science Teachers; Dr. John DeBlasio of Upper St. Clair High School; and Mr. George Murphy, Pine-Richland High School, a panel of secondary level school teachers.

Why don't you start the panel and I will be right back.

Mr. BATEMAN. Welcome to the second group of panelists this morning and I would suggest that we go forward as we did before, in the same sequence in which you were introduced.

I will first recognize Dr. Caretto. Doctor, welcome.

STATEMENTS OF DR. ALBERT A. CARETTO, DIRECTOR, PENNSYLVANIA GOVERNOR'S SCHOOL FOR THE SCIENCES; JANE KONRAD, PITTSBURGH REGIONAL CENTER FOR SCIENCE TEACHERS; DR. JOHN DeBLASIO, UPPER ST. CLAIR HIGH SCHOOL; AND GEORGE MURPHY, PINE-RICHLAND HIGH SCHOOL

Dr. CARETTO. I thank you very much for the opportunity to be here.

I wear two hats in a sense. As a professor of chemistry at Carnegie-Mellon University every fall I teach a freshman chemistry course and I see 600 students from across the country, products of our secondary education. And in the summer I am a director of the Pennsylvania Governor's School for the Sciences.

What is the Pennsylvania Governor's School for the Sciences? This is a summer school created by the Department of Education in Harrisburg with the objective to provide an enriching experience for bright and talented high school students and ultimately to hopefully lead them into choosing careers in technological areas.

The school has been in existence for 2 years now and it is a full scholarship program. It is financed through the Department of Education of Pennsylvania, with a number of contributions from charitable foundations. The students receive a scholarship which covers their tuition, room and board. They live for 5 weeks during the summer on the campus of Carnegie-Mellon University.

In 1983 the class consisted of 60 students chosen from over 3,000 applicants. The basis for selection is on class rank, teacher counselor recommendations, performance on SAT scores, and evidences of motivation; and this past class we had three students whose SAT scores were 1600 and that, of course, is the full maximum you can possibly get. So it is an exceedingly bright group of students.

They arrive on the campus of Carnegie-Mellon University and immediately get involved in a very intensive program. They take courses, all of them are required to take courses in biology, chemistry, physics, computer sciences, mathematics, simultaneously.

They take laboratory courses, some elective courses are available, and every student must join a team project for individual research. They choose the area of science they want to participate in.

We suggest research topics. They join forces and make teams of three to five students to work on individual research projects.

Classes begin at 8:30 in the morning and they are in class until 12:30 without break. They have an hour for lunch and then four afternoons a week they are in laboratories from 1:30 until 5 o'clock. They then have an hour and a half for dinner and practically every evening there is something, either an elective course, a guest lecturer or time for homework and their team projects, which also goes on on Saturday and Sundays. It is a 7-day-a-week program.

Some of the philosophies of the school and how this might tend to relate to the situation in the secondary schools.

First of all, we are legally not allowed to give high school credit and we do not give college credit, so the students come giving up 5 weeks of their vacation to a school which requires a tremendous amount of work. It is terribly intense and they get no credit for it.

Second, we tell them they will get no grades. There will be no letter grade, A, B, C, or whatever, in any of these courses. The only thing that we tell them that they will have and the only leverage we have over the student is that 5 to 6 weeks after the program is all over they will receive from us in the mail a narrative evaluation as to how well we feel they accepted the challenges we provided.

This only goes to them, presumably their parents as well, and only upon their request does it become part of their high school series of records or would we send it to anybody else.

The vast majority of the students write to us and ask us to send it to colleges of their choice and they find it very helpful for getting into college.

In the first 2 or 3 or 4 days of the school the students are frustrated, confused, because of a system that they are not at all used to.

As I say, we start off immediately. As a matter of fact, they come on a particular Sunday with their parents. They move into the dormitories. There is a brief orientation. They have dinner with their parents. Their parents go home and that same evening they get an exam. You start off with an exam.

The next 2 or 3 days, as I said, they have some of this frustration largely given the fact that they know in high school how hard they have to work to get an A, and all of a sudden they are in the environment where the amount of work that is given them is endless and they have no idea how hard they have to work because we are not even going to give them an A.

The object of the game is to try to develop motivation for these students and to hope that they will plug themselves into this learning process and become enthusiastic and work.

We provide them open-ended assignments. Fundamentally what we do is give them an assignment and say that you should turn in tomorrow the following. However, if you wish, you may also do these and beyond that you may also do something else.

The challenge is endless. It goes on forever. We do not, despite the selectivity of the students, we do not get students with uniformly equal backgrounds because according to State regulations we accept students who have either completed their sophomore year or their junior year. So there is a difference in age that way, as well as the fact that they come from school districts across the State and thus they vary in their preparation.

What we try to do is allow these students to plug themselves into the challenge process, the series of exercises we have, and grow from there and measure from there.

What happens then, after 3 or 4 days, is that everything settles down and all the students begin to work exceedingly hard. There develops rapidly a feeling of friendly competition. They help each other. They work hard and they do not feel something which I think is prevailing in high schools and is a fundamental problem; they do not feel the negative peer pressure in the high school which is the antiacademic development of excellence, because they all have the same curiosity that they wish to excel.

I will share a quick little story. I overheard a conversation between four or five of these students last year. They were talking about what did you tell your friends when you came to Pittsburgh for 5 weeks as to how you were going to spend your summer?

The four or five together all said, well, I certainly was not going to tell them that I was going to spend my summer vacation in school at Carnegie-Mellon. I made up something. I told them I was going to visit relatives in Pittsburgh. We are going on a trip for 5 weeks but none of my friends know where I am.

I think that statement is a very terrible reflection as to the attitudes that prevail, and I think until some of those concepts are changed right down to the grassroots and into the homes, so that

people will realize that academic excellence, the objective to do well in science is something which is good for the country, until those things are changed, then we have problems.

The school is a success. I am involved in it, so I feel somewhat awkward in saying that it is a success. But I believe it is a success.

We have hundreds of letters from these students who say it was the greatest thing that ever happened to them. The students from the 1982 class are all in college and they go to colleges like MIT, Harvard, et cetera, et cetera. So the school, I believe, is a big success.

How can we use some of this in a high school framework? Clearly you can't just take it and lift it and put it there, but some of the philosophies may be useful.

More and more high schools are providing courses in biology II, chemistry II, calculus. These are the upper level courses for those students who are motivated.

Perhaps one could conceive of using some of these philosophies in running those courses; pass-fail courses, where with a threat of working for a letter grade is now gone. Where the only objective is I am working to learn. I am not being measured with respect to my other friends. I am just being measured as to how well I learn.

If the atmosphere can become infectious in that environment, like it is in the Pennsylvania Governor's School, then the negative tendency from all the other students may gradually be eroded. It might be wishful thinking to see this happen, but somewhere along the line we have to try to bring in a way of getting more enthusiasm into the teaching of students to follow the sciences.

I want to make one or two other quick comments and that is that the preceding panel referred on several occasions to providing better background for teachers in their subject matter.

The Pennsylvania Governor's School faculty is made up of, to a large extent, professors from Carnegie-Mellon, some faculty from other institutions of higher learning in this area, but also some high school teachers.

The vast majority of nearly 100 percent, 90-some percent of the faculty do not have teaching certificates. We cannot teach in the secondary school classes, but we teach at the university level, and what makes this school successful is the fantastic enthusiasm of the faculty, the fact that the faculty knows the material, knows it backward and forward and is enthusiastic to try to convey this.

I believe that those are some of our serious problems for the future to try to develop a teaching faculty, an enthusiastic one, and one which is strongly educated in the subject matter.

Thank you for your time.

[The prepared statement of Dr. Caretto follows:]

The Pennsylvania Governor's School for the Sciences: A Possible Model for the Improvement of Secondary Science and Mathematics Teaching

A. A. Carotta
Carnegie-Mellon University
Director of the
Pennsylvania Governor's School for the Sciences

The Pennsylvania Governor's School for the Sciences was created by the Department of Education of the Commonwealth of Pennsylvania in 1982. It is a five week summer school for some of the brightest science oriented high school students in Pennsylvania. The overall purpose of this school is to provide an enriching experience for highly motivated students and to encourage them to seek careers in technological disciplines.

The 1983 session of the Pennsylvania Governor's School for the Sciences was held at Carnegie-Mellon University from July 10 to August 13, 1983. From over 3000 applicants sixty very bright and talented high school students from across Pennsylvania were selected to participate by the Pennsylvania Department of Education.

Successful applicants were "A" students in high school, strongly recommended by their teachers and counselors, at the top of their classes, and in the 99th percentile category on SAT examinations. Their applications were often supported by evidences of participation in various kinds of science fair projects.

The students lived in a dormitory on the campus of Carnegie-Mellon University, seven days a week for the five week program. They enrolled in lecture courses in biology, chemistry, physics, mathematics and computer science, laboratory courses in biology, chemistry, and physics and had an opportunity to select several elective courses. In addition each student participated in a team project in the scientific area of their choice. Their experience was enriched by a distinguished guest lecture series, field trips to local scientific and industrial laboratories, and special presentations on career guidance, leadership, and how to get into the college of your choice.

Student performance was evaluated by the faculty of the PGSS. Students were not ranked against each other. Rather, they were evaluated on the basis of how well they responded to the challenges of the program. Each student received an individual narrative appraisal.

Program evaluation is based primarily on student responses. Each student had an opportunity to evaluate each course as well as to partake in a comprehensive evaluation at the end of the program.

The objectives of the school are to provide an opportunity for bright high school students to enrich their background in the sciences and to satisfy their curiosity. The school provides an opportunity for these students to use scientific equipment not normally found in any high school, a chance to become engaged in original laboratory experiments and research, and an opportunity to meet and interact with professional scientists and mathematicians. It is hoped that participation in this intense program will help generate enthusiasm for science and technology, indicate the level of commitment necessary, and lead to the selection of careers in technological areas.

GOALS

The Department of Education of the Commonwealth of Pennsylvania has established the following goals for the Pennsylvania Governor's School for the Sciences:

1. To identify and encourage students who show exceptional promise as potential scientists and engineers to continue their efforts in a technical discipline.

2. To develop a new, advanced level curriculum that will aid these students in expanding their capabilities and interests.

3. To foster and reward excellence and creativity among secondary school students by identifying and including them in this unique enrichment experience.

4. To especially encourage able women and minority students to consider scientific careers.

5. To encourage local school districts to upgrade their science programs, increasing the quality and diversity of their offerings.

6. To emphasize the vital role of science and technology in our society and the impact of society upon scientific endeavor.

7. To train student leaders who, upon return to their local school districts, will serve as role models for their peers.

8. To provide scientists as role models for student participants.

All students were expected to enroll in courses in biology, chemistry, physics, mathematics, and computer science. At the end of the second week of the program they were permitted to substitute up to two elective courses for two of these courses depending on their specific interests. All students participated in laboratory courses in biology, chemistry, or physics and participated in a team research project in the area of their choice: biology, chemistry, physics, computer sciences, or mathematics.

The program was very intense. The students were in classes generally from 8:30 AM to 12:30 each day and then had their laboratory courses in the afternoon. Evenings were devoted to elective courses, study, guest lectures, and socialization.

The students selected for the School were considered to be among the very best academically by their high school teachers and counselors. They were clearly highly motivated. Since the School runs during their summer vacations they were willing to give this up for an intense learning experience. The School does not provide credit for either high school or college courses. Upon completion of the program the State presents a certificate.

The philosophy of the PGSS was not to attempt to rank each of these clearly bright students against each other. No grades are given in any of the courses. However, each student does get a narrative evaluation of the faculty's appraisal as to how well they responded to the challenges presented by the School. Since these evaluations can be useful to the student to get accepted by the college of his or her choice, most students were strongly motivated to do well.

Many of the students experienced an initial confusion and frustration by the philosophy of the PGSS. In high school they knew how hard they had to work to get an "A". In the PGSS they knew they would not get a grade. But they also were given extensive homework assignments, frequently of an open-ended variety, which they were expected to complete. In other words, the School provided them with a challenge, expandable to be as big as they wanted, with the only reward being the satisfaction of their curiosity.

Despite the lack of the possibility of receiving high school or college credit, despite the lack of grades, despite the highly intense atmosphere for the full five weeks, the students rapidly accepted the challenge of the school and the atmosphere becomes one of highly friendly but intense competition. Since the student body of the PGSS is made up of students having completed either their sophomore or junior years, their backgrounds are not uniform. Also, not all school districts have uniformity equivalent courses. Therefore, an important ingredient of the PGSS philosophy is that each student reach-out for the challenge presented at a suitable level commensurate with the students' background.

This philosophy places a burden on the faculty to find ways of measuring student performance in comparison with their background at the time, as well as to attempt to measure academic growth.

The philosophy of an open ended ever expanding challenge, as well as no grades appears to be highly successful. These students are very highly motivated. The inquiry for knowledge became the dominant force permeating the School. Since the entire student body shared most of the same objectives, the students did not feel the anti-academic pressures which tends to be the rule in most high schools and which is so costly with regard to maintaining high student aspirations.

A copy of the Follow-Up Survey of the 1982 Class of the PGSS is attached. Included in this survey are student anecdotal replies which provides an insite as to their opinion of the success of the PGSS.

Can these philosophies be employed in the typical high school and used to generate better student enthusiasm and learning? It would be naive to think that these techniques could be applied to the current high school science. Some of the reasons why this would not work are:

1) too few students with a highly motivated desire to learn
2) too strong peer pressure which puts "down" academic achievement
3) too wide a distribution of student talent in any one class
4) too few teachers with sufficient dynamic enthusiasm
5) too many distracting influences in a typical high school.

However, the PGSS philosophy might be initiated in the high school setting on a limited basis to provide a gradual improvement of the academic atmosphere for learning. Some of these philosophies might be initiated in the advanced levels of some of the science courses, such as biology II, chemistry II, and physics II as well as, perhaps, calculus. These courses are normally taken by the academically superior students in any given school district. Thus, it might be possible to implement the following:

1) Pass/fail grades for advanced science and mathematics courses.
2) Open-ended challenges for the students commensurate on the students ability.
3) Expose teachers to the PGSS so that, by interacting teachers with a class of very bright students they will return to their class rooms highly motivated and full of enthusiasm.

These ideas should help to develop an infectious learning atmosphere, even if restricted only to the very best students in a high school. The pass/fail grading, if coupled to an appropriate intellectual challenge, should begin to turn-on students. Once a reasonable number of such students can be developed and maintained, the anti-academic atmosphere of the high school will slowly be diminished. Only then can real advancements be made in the academic improvement of science and mathematics teaching in our high schools.

Mr. BATEMAN. Doctor, thank you very much. I hope we will have time to come back with some questions, but I think now we should ask Mrs. Konrad for her testimony .

Mrs. KONRAD. Thank you.

I, too, wear more than one hat. I teach advanced biology at this time, but I have also developed and worked with laboratory based science programs for elementary schools, a love of mine, and I think one of the basic things we need to address today.

My written testimony has been supplied to you, but I will just now address a few points that I think are very important.

I agree heartily with all the prior testimony. I think that someplace along the line we have lost it and that is what we are trying to find out.

Where did we lose it and where are we now and where can we go?

All children begin as scientists. They are curious. They are very eager to go through all the process skills, to observe, to analyze, to categorize. They want to bring order into their life. They are willing to do it. They have the time to do it. And if we provide them with the resources they can do it.

We need, of course, to look at the idea of developing all skills concurrently. When I speak of science, I am speaking of math science as being one and the same thing. To me these are life skills. It is problem solving and I think we have categorized and put things in compartments for so long that we are no longer looking at life skills or problem solving skills which is probably the basis of what we are about today.

The problem that exists is not new. It did not come overnight and I don't think we are going to be able to erase it with any kind of panacea overnight either.

The grade inflation that followed from the permissive fifties and the pass along to the next grade policy whether the student mastered the next concept or not was, I think, part of it.

Then we had the Vietnam war coming along and there was a very sympathetic response for those students who wanted to be in college and not go to war and I think we are still suffering from all of these things, and I think we have to look at what caused it as well as how we are going to go about fixing it.

All of this has led to a change in attitude, I think, toward a lot of things.

The work ethic that you mentioned I think was one and I think toward the teaching profession was another.

These attitudes exist outside the profession. Teachers are seen very often as those who cannot do so they teach, and the teachers at the elementary level are often seen as those who just can't teach well enough to be at a higher grade.

The higher grade levels are supposed to have teachers who are smarter, who teach better, who know more, and then if you are really good you get to teach at the college level where you are not certified to teach at the elementary level.

It really doesn't make a lot of sense.

There is a lack of respect generally for what teachers can and cannot do. This is transferred to the students not by any didactic means but teachers teach many things in their classes besides con-

tent. They teach children how to learn, what to learn, how to go about doing it and how to live their lives and these things are transferred at very early levels and I think we have to look at that, too.

Within the profession, unfortunately, we also have a hierarchy of attitudes about what level you teach and what you teach and science teachers are often seen as not being important teachers. Reading, writing, and arithmetic is what is important.

We can't read science or use math for science. It has to be compartmentalized and put between 2:45 and 3 o'clock on a Friday afternoon, and I think that has been addressed so I won't go into that.

But that exists and we need to look at those attitudes both without and within the profession and see if we can alter that in some way certainly concerning the attitude concerning science and math.

If, particualrly at the elementary levels where your foundation is being laid, and we have talked about that earlier, if the teacher views science and/or math as being hard or being uninteresting and sometimes even disgusting, you know, "A worm, who would want to dissect a worm?" This is transmitted to the students and by the time that student is graduated from elementary school or perhaps even long before that, sometimes we find by the third grade, that interest in science is dead and it is going to be very difficult for any teacher further along the way to try to bring that attitude back to the proper level.

This begins negative feedback.

I quoted Arnold Aarons in his article in the Journal of Teaching this month talking about this terrible degenerative feedback loop. If you impart this idea to the students and they go through school with this attitude and graduate, they are not apt to go into a scientific field.

Those who have any interest at all in science and math and who might want to go into teaching might and have proven to be at the bottom of their levels, so that you are getting poorer and poorer students entering teacher training. So that what you are certifying are teachers who have less and less interest and less and less real scientific baseline education coming back into the schools to teach your students, so that it is just a terrible cycle. And what we have to do is to somehow intervene in that cycle and see if we can break that. And I think one of the prime ways we can do that is in alteration of attitudes and certainly we have heard of some ways that you can do that today.

I think this program is a good one. The media needs to be involved in some way and other organizations working with these problems need to be involved.

Mrs. KONRAD. I represent also the Pittsburgh Regional Center for Science Teachers which was a bootstrap attempt to work at a national and regional level for science teachers getting together and having a clearinghouse for information and that indeed is what the center is. It is a clearinghouse for information, for a sharing of ideas. And right now we are working very hard to put into a computer system all of the resources that can be utilized to teach science that already exist here in the Pittsburgh area, but about

which teachers may not know or may not know how to use. If we can cross-index this according to topic and grade level, with one phone call the teacher can save a lot of time in finding what that teacher needs to teach that particular part of the unit.

So these kinds of organizations, if they are funded and developed, can help the teacher to manage time which is at a premium at this point and to be more effective in their teaching.

And in order to have quality teaching we have to have teachers who can provide quality teaching so that what we need is to arrange for them to be able to do this.

Time is one of the aspects that has been mentioned before, but certainly it is a primary one in solution.

We need time to teach problem solving. You can't do that in 15 minutes and you must start in kindergarten through the 12th grade. In the sciences you have laboratory preparation. Indeed we are swinging back toward a textbook-oriented curriculum which is not the way to teach, but it takes a lot of time to get this equipment out and plan the lab so it is integrated into what you are lecturing about and to clean up afterward.

Perhaps you want to know about new technology and instrumentation, but you don't know how to use it. Even if someone buys it for you you don't know how to use it and if you learn how to use it you don't know how to integrate it into teaching the students to use and apply what they are learning.

This takes a lot of time, more time than the teachers have. There is just a plethora of new content appearing in the daily newspapers and all through the lay journals and into the scientific journals. Almost daily new content is coming out. New discoveries are being made and it is almost impossible to keep abreast of this. And that is one thing that we hope that PRCST can do is make this available information easy to access for the teacher because the teacher just does not have time to do this.

We want to base what we are doing on what the teachers perceive as their needs rather than what someone thinks that the teacher should have or what the teacher does need and this is the basis of what we are doing.

We did a survey of Alleghany County teachers and we asked them to give us a priority ranking of what they perceived as their needs, and high in that ranking was help with new technology, computers, scientific equipment, use of the media and not just buying them and putting them in the classroom, but help me learn how to use and integrate them.

One was that we can do this, and one way we can improve science education as well, and it helps the situation that we see now for many people being unemployed—this can improve science education. Many of those scientists are coming back and going into teacher training. The University of Pittsburgh School of Education had more than 70 unemployed scientists this year apply for training and certification in teaching. This is a marvelous quick remedy which not only helps the unemployment situation, but brings highly trained people to the teaching profession. So we can look at these means of providing at least quick partial relief to this tremendous problem that we have.

One thing that teachers saw that they needed was help with new techniques, new methodologies. They are aware that these are out there, but they have not time to develop them on their own. Where this time and money will come from is something that we will have to address, but certainly that is a prime problem and they do need to share with others. It is much simpler if you can say to someone else, "I really don't know how to use this," or "I really failed when I tried to do this. Do you have any techniques that will help me?" And if one person says, "I don't know," the next one will too and then you are willing to reach for help.

I think the attitude in the profession becomes really a kind of machismo, "My class is really tough and hard," and this not only turns the students away but the teacher does not progress either.

These are the kinds of things we have to look at to break into this cycle.

We also need administrative support. The teacher can't go this alone. Administrative support in terms of attitude as well as time and money. If the attitude is not there, no amount of equipment or inservice training time is really going to help. If we can alter this deadly routine of just teaching the same thing day after day, revitalize the teacher, we can spark the spirit that Dr. Caretto spoke so well about which we have to have if we are going to improve the science education for the children because, as you all know, enthusiasm is contageous and if the teacher is not enthusiastic about what is going on in the classroom, you can be certain that not very many of the students will be either.

There are those few who regardless will excel and enjoy science and probably will become good working scientists one day, but for the most part you can't bank on that.

Community involvement is extremely important if we are going to eradicate the attitudes at all levels, from the parents all the way up to the Federal Government. We must have some involvement there in our attitudes toward teaching in general and certainly toward teaching in science, but there are solutions that are out there. I have tried to outline some in my testimony.

I think in ending here I would like to summarize four major points. Provide more science background for science teachers. In other words, it is much simpler to take a scientist and teach the scientist to teach than it is to take a teacher and try to train them to teach science. Provide more science resource people at lower levels. You can do this quickly. Even if you can't rectify the teaching strategy at that level, you can provide science resource people to help the teacher be comfortable with what it is they are teaching.

You can let teachers have more input into policymaking because they know what they need. They are on the firing line day after day and they are more able to tell you what they need than someone in another position.

And by all means, let's encourage and nurture spirit and enthusiasm because without that everything is really lost.

Thank you for having this hearing and for focusing on science education. We do need it.

[The prepared statement of Mrs. Konrad follows:]

PROST

Pittsburgh Regional Center
For Science Teachers

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Hearing on Math and Science Education at Primary and Secondary Levels
Committee on Science and Technology February 10, 1984
Pittsburgh, Pennsylvania

A crisis in science education dominates the headlines and provokes national dismay. Yet it is an ill wind that blows no good. And while science teachers cannot be totally and solely blamed for putting our "nation at risk", the spotlight on science education is long overdue. Hurry up science education patchwork after the Sputnik scare led to thoughtful development of broad and thorough curricula for all levels. Materials development kept pace as kit after kit offered instant science teaching and met all evaluative standards generally accepted.

Where, then, did we "go wrong". What happened? With more students attending school and staying in school for more years, where is the well-prepared high school graduate? Colleges and industry bemoan their enforced roles as remedial educational institutions. And students turn away in greater numbers and earlier in the process of obtaining a basic science education.

The fact that funding for those post Sputnik programs was reduced and finally eliminated is at least partly to blame. The impetus was lost. No provisions were made to continue teacher training and curricular development. The programs in operation were unable to replace the consumable materials and there was no training for new teachers entering the field. Apathy set in. Interest was lost. With the exception of the work of some very fine, dedicated teachers science education settled into a routine, especially at the lower levels.

In recent years the research of Jean Piaget (Swiss Biologist) in cognitive development has thrown a lifeline to educational specialists. The current idea has it that if only we would order our curricula to his outline of cognitive development all might be well with the science world.

If, indeed, a science curriculum can fit the students' transition from concrete to abstract reasoning and cognitive conflicts are arranged to occur at proper intervals, then perhaps learning will occur that might amaze us all. This would surely be true if progress in math skills would parallel and complement the development of science concepts. Training in problem solving and working with abstractions has been shown to be effective. But students must develop all skills concurrently for success to occur. And the teacher must have the time for patience plus the opportunity to allow the student to try, fail, alter course and try again in building

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a concept.

The main problem, as every teacher knows, is that students just do not progress evenly. In fact, there are those who will not ever achieve the ability to perform abstract reasoning. And no amount of mandating more science courses and more and better science teachers will result in reaching this goal. What then should our goals be? What policies will we set? And while they are not mutually exclusive, the fine aims of 1) higher scores on standardized tests and 2) greater individual capability to find order and cause in the day's events need to be assigned a value. And as many others have mentioned, we need to consider the value of the spirit along with the particulars of science teaching.

It is this latter - the spirit - that may be the missing link. Arnold Arons, Professor of Physics Emeritus, University of Washington, in the February, 1984, Journal of College Teaching speaks of the "consequences of mismatched intellectual levels and modes of instruction, or, the degenerative feedback loop." For teachers teach not only the subject, but they also teach ways of learning along with ways of living. Students quickly learn from their teacher "how to learn" and "what to learn". Value systems are imparted if not taught. When teachers view science as hard, uninteresting and even disgusting, these values easily transfer - especially to the young student. And the cry for more and better may result in short range answers. We need to revise the standards for training teachers - so that they provide motivation and reward for being a professional. To achieve QUALITY teaching, there must be RESPECT. This has been in short supply for teachers for some time.

The public has increasingly viewed teachers as those who can not "do". And the less well qualified were usually relegated to the lower grade levels. Even within the profession there exists a hierarchy of attitudes - "the good teachers move up into the higher levels - expert ones teach at the college level." This attitude has been reinforced by the drain of science teachers into industry where they seek higher incomes. Respect for male teachers falls to even lower levels. And men are conspicuously absent in early childhood education.

Emphasized,if not initiated,during the 1960's, the latitude in teaching was attenuated and the authority of the teacher diminished. It was implied that the teacher should not try to influence the student too strongly. It was the era of the "fragile ego" with a focus on psychic trauma caused by undue pressures. A generation decided to look at "me" and rebel against civilized constraints found to chafe - physical, emotional and intellectual. The grade inflation and pass-to-the-next-grade policy found its way into the college level with the Vietnam War. Mighty efforts to remain a student and thus gain a deferment were made by many and there was a sympathetic response. We have yet to recover from the effects of this. Now we find that the limited knowledge and skills of high school graduates is accompanied by a low level of personal expectation. Then, if these students enter the field of education, they are poorly prepared to inspire and educate their own students.

There may be no formula, scientific or otherwise, that will offer the answer to this complex problem. However, there are ways we can begin to work to solve at least some of the puzzles.

1. Work toward a positive feedback situation in science education, primarily at the elementary levels. This will involve much support and training for those teachers already in the schools as well as for those entering the profession. There is a basic need to provide the student with a positive view of science - science as a way of living, a vital aspect of life rather than a subject to be studied. Train scientists (retired, unemployed, male, female) to be teachers (far better than trying to provide teachers with a science background).

2. Provide support for science teachers to enable them to keep abreast of the rapid and constant changes occurring in scientific fields. It is not enough to "expect" teachers to know about the latest technological advances and perhaps even to utilize the instrumentation within their curricula. They must receive help in learning about and using these. It takes great stamina to teach and this continuing education could even serve as a revitalization in a demanding profession.

3. Promote administrative support for the necessary time and money to allow science teachers to prepare and teach a meaningful curriculum. Not just science, but the entire educational system in America seems to be geared to teaching specifics which students learn and play back for a test. This can happen at all levels without the student understanding the concept or being able to relate the learning in any way to anything else that is learned. Bigger and better performance standards do little to alleviate this situation. It is impossible to legislate morality or understanding. As Susan Ohanian (Learning, February, 1984) so clearly put it, "....it bespeaks an underlying arrogance and presumption that contradicts the very nature of learning: 'The student will master six irregular verb forms'. Anybody who knows anything about kids knows that maybe the student will and maybe he won't. And even if he doesn't, blue-ribbon commission report writers should not take this as proof positive that he or his teacher is an idler."

   Inquiry and other methods arriving at understanding require more time and effort then may be possible in today's schedule. But without a way to observe the facts, find the gaps, understand the assumptions made, analyze the observations and draw some meaningful conclusion, there is no informed citizen to examine national and world issues and to vote with expectation. Time is the key to success.

4. Initiate total community involvement - parents, business and industry, and government - in providing the materials and opportunities necessary for students to gain positive attitudes towards science. Create a working relationship between college and pre-college teachers.

In our search for solutions, let the teacher remain not the problem, but rather the answer. For they are on the firing line, and often know what is possible when others do not. School is not a production line nor should it be a business. It is a place to nurture the greatest resource we have, the minds of our children - the leaders of tomorrow. This is the basis for the establishment of the Pittsburgh Regional Center for Science Teachers (PRCST) ... an independent, Not-For-Profit organization designed to support science teachers and answer to their needs. Easy access to the resources in the Pittsburgh area is a primary goal (using a computer system to provide a database of science resources cross-indexed by topic and grade level). The needs of the teachers determines the course of action and provision of aid. Acting as a clearinghouse for information, and potentially for materials and science equipment, PRCST offers teachers a way to share problems and solutions, deficiencies and expertise, desires and hopes. Teachers can be helped to teach just as students can be helped to learn. But in the end, each must go it alone. What we must make available is what is needed to accomplish the task - the tools, the resources, and the support.

This survey was done to assess the needs of [illegible] in Allegheny County school districts. Survey copies were sent out by the Allegheny County Intermediate Unit. One hundred and six of the responses were found to contain all of the requested information (there was a 52 % return).

The teachers were requested to rank 16 service statements with regards to the urgency of their need in the teaching of pre-college science. The ranking was in terms of urgency; with a value of "5" for the most urgent need.

The following table lists some of the trait information for the teachers. The high school teacher sample was of respondents who had more years of teaching experience than the teachers of other levels. The mean of 17.1 years teaching experience was similar to that reported in a recent edition of Education Week (27 July, 1983; Volume II, No.39). That publication reported results of the National Science Teachers Association (1982-82), which indicated the mean age of science teachers was 41.6 years and that the mean amount of teaching experience was 16.7 years. It is quite possible that the similarity of average years of teaching experience of high school science teachers indicates this survey had responses from a representative sample. The highest degree earned by the teachers participating in the survey indicates that one third or less of the group of teachers held only a bachelor's degree.

TABLE I

A. YEARS OF TEACHING EXPERIENCE

Teaching Level	N	[illegible]	[illegible]	Q_1	Q_3	Range
Elementary (K-6)	52	[illegible]	[illegible]	10.0	15.0	0-29
Junior High (7-8)	12	[illegible]	[illegible]	6.5	14.0	0-18
High School (9-12)	42	17.1	8.1	11.0	23.0	3-34

B. HIGHEST DEGREE EARNED (in percent)

Teaching Level	Bachelors	Masters	Doctorate	N.A.
Elementary (K-6)	28.8	65.3	1.9	4.0
Junior High (7-8)	33.3	66.7		
High School (9-12)	23.8	64.2	11.9	

The needs of the teachers who responded to this survey are summarized in Table I. That summary includes ten listed expressions of needs. As indicated in the preceding section of this report, there were 16 needs listed in the survey instrument. However, the six unlisted, see Table II, had too few responses for being herein reported (see appendix A for a complete list of items used in the survey). The analysis used for this report was based on a variable scale of six intervals. This was for the

five-value response (as for one to five); with the value of five indicating the most urgent need; zero for no response to an item). The average value of response to a need item, reported in Table II, is thus one which includes no response entries. The reader can interpret those mean values as meaning that greater values indicate more urgent needs for the stated service for the teaching of science.

The respondents to this survey differed as to the level of urgency for their needs. This urgency was a function of the grade-level assignment of teachers. One can stratify those needs in terms of either the mean value of degree of urgency or to the proportion of teachers in each sample indicating the need of a specified service. A suggested approach is to qualify priorities of needs in terms of those four most urgent needs.

The most urgently expressed need of each group of teachers show that there were differences; as a function of the grade level assignment of the teachers. The most urgent need of elementary school teachers is for a listing of free or inexpensive materials and loans of materials (reported as a need by 56 percent). It should be noted that respondents were requested to rank needs in terms of values of one to five; with a five value being that most urgent need. Junior high school science teachers (arbitrarily defined as grades 7-8) had the most urgent need of a list of technological developments in all areas of science. One-half of the teachers (N=12) indicated this as an urgent need. However, two thirds of the sample of respondents indicated a need for computer workshops. That same service was regarded as most urgent for teachers of secondary school (grades 9-12;N=42).

The other three most urgently needed services for elementary school teachers were:

1) computer workshops
2) speakers from various fields
3) listings of classroom materials for enrichment experiences

Junior high school teachers had needs for:

1) lists of new teaching techniques
2) computer workshops
3) listings of free and inexpensive materials and loans of equipment

Teachers of secondary school science (grades 9-12) had needs for:

1) lists of special demonstrations
2) updating of technological developments in all areas of science
3) lists of new teaching techniques

[illegible] be applied that there are a small number of needs that [illegible] passive, depending upon the level or grade of their assignment. It should [illegible] that the following cluster analyses of these needs are: 1) linearly related to the traits of the professional practices of teachers; defined for the levels or grades to which they are assigned; 2) linearly related to each other. The reader can conclude that, from this survey analysis, there are certain services, which if met, would meet the needs of a majority of the teachers in this region. This observation is justifiable as almost one-half of the responding teachers indicated each of these prioritized needs.

[illegible] figures are dendrograms, or [illegible] variables of this survey. This statistical technique groups variables into clusters according to their linear relationship with each other. The term dendrogram was derived from its technical inception in the field of biological science (as in dendrology). The pattern of the displayed configurations (see figures) is that of branches of an inverted tree. Pairs of variables are initially formed for their linear relationship. As seen in the figures, the vertical scale is of correlation coefficients. The more related are the pair of variables the higher will be the reported coefficient in a dendrogram. A pair of two variables is called a cluster. Those clusters are then linked with other closely related single variables or with other clusters of two or more variables. These linked clusters are formed by amalgamations of clusters. Thus one can observe a hierarchy of amalgamations of clusters, which proceed to link single or groups of variables at levels of lower correlations or relationship.

The dendrogram of need responses and the traits of the elementary school teachers is shown in Figure 1. The most related variables were those for the areas taught and previously taught by the teachers. This correlation was .95 indicating an almost perfect correlation. This occurred because there was very little fluctuation in what area was taught, e.g. science or [illegible] science. That cluster was amalgamated with the levels [illegible] taught and previously taught by the teachers. It may be noted that such a cluster of these traits were not found in the dendrograms for samples of junior high school teachers (Figure 2) or high school teachers (Figure 3). The survey responses of those teachers indicate that there was greater mobility of the teachers in secondary schools. That is, possibly due to decreased enrollments and seniority, biological science teachers in particular were reassigned to other course levels. The teaching traits were linked to several expressed needs of the elementary school teachers. In the order of amalgamations, as a hierarchical trend of urgency of need, these were: 1) listing of free and inexpensive materials, 2) help from qualified advisors, 3) update of technological developments, 4) list of teaching techniques. This large cluster was then linked to the trait of the teaching experience of the sample of elementary school teachers. This relationship highlights an interpretational principle of this analysis. The survey record of the instrument

requested respondents to enter a value of "five" for the most urgent need. Thus in defining dendrogram results an inverse relationship is made for correlations of needs variables and those for traits. Thus, the teachers with several years of teaching experience indicated a greater urgency in needing a listing of free and inexpensive materials for the teaching of science, than that expressed by more experienced teachers. The same interpretation exists for the other needs included in the discussed cluster of variables. Another major cluster of needs was found in the dendrogram (Figure 1.) The hierarchical ordering of these needs were: 1) listing of field trips, 2) list of multi-media resources, 3) list of special demonstrations and 4) a list of special materials and equipment available in loans. The variables were clustered with the trait for the highest degree earned by the sample of elementary school teachers. The interpretation,as explained previously, is that teachers with less formal education, e.g. a bachelor's degree, indicated a greater urgency in needing these services. The dendrogrammatic analysis indicated that there was another clustering of expressed needs of the elementary school teachers. This was the need for computer workshops, speakers from various fields and a linked need for a list of teacher exchange programs.

Figure 2 shows the dendrogram of needs and traits of the junior high school teacher sample of respondents. The greatest relationship was between the teaching experience of teachers and a need for lists of special materials anhd equipment. The indication was that teachers with less experience expressed the most urgent need for the listing. That cluster of related needs included lists of classroom materials for enrichment purposes and of special demonstrations. Linear relationships were also found for several clusters of pairs of expressed needs. A relationship existed for lists of field trips and of sciecne related curriculum materials. Another pair was listings of science activities for independent study use and of teacher exchange programs. A logical relationship existed in expressed needs for lists of speakers from various fields and qualified advisors. The need for listings of lesson plans and of teaching techniques was also linearly related. The junior high school teacher's responses indicated there was a relationship between needs of listings of free and supplemental materials. An interesting finding was that these teachers had an expressed need for computer workshops but it was not signi-

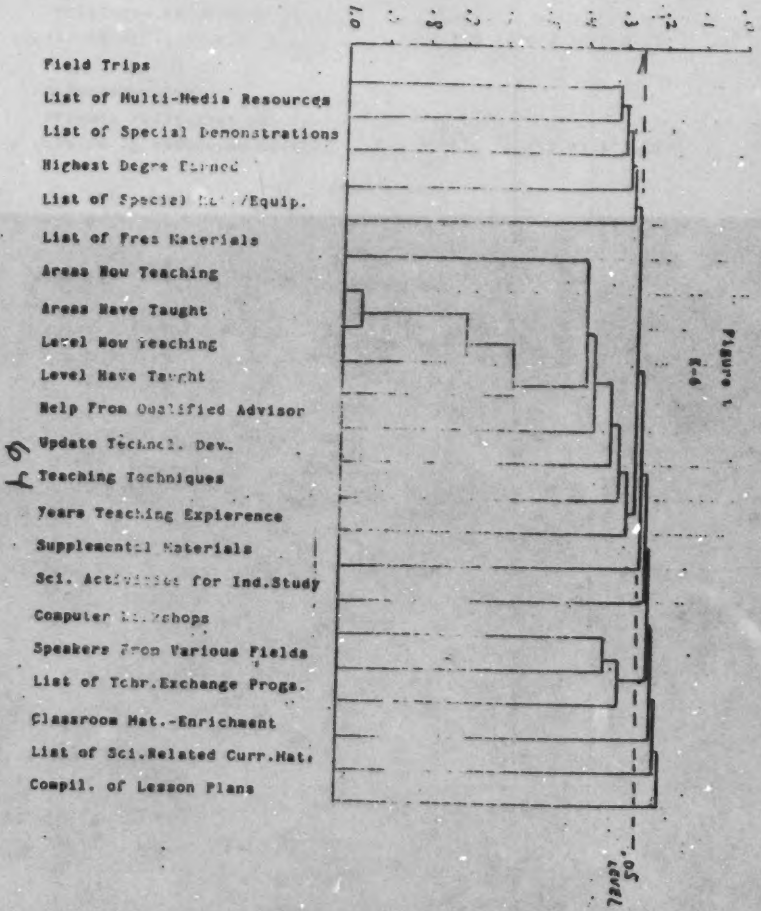
fi[illegible] related to other needs.

The dendrogram for the high school teacher sample is found in Figure 3. A large cluster of variables was developed for several of the most urgent needs of that group of teachers. These needs were science activities for independent study, computer workshops and speakers from various fields. These needs were marginally related to their expressed need for a list of special demonstrations. That cluster also contained the trait of the science areas the respondents now teach.

Another cluster consisted of the expressed need for listings of free and inexpensive materials, supplemental materials and multi-media resources. A smaller cluster was of their need for help from qualified advisors and compilations of lesson plans. There was a relationship between the level or grade they now teach and need for a list of teacher exchange programs. Teachers of the lower secondary grades indicated a more urgent need for the exchange listing. A similar trend occurred for the need of lists of new teaching techniques. Science teachers with less education (fewer degrees) indicated the more urgent need. The need for a list of field trip locations was not linearly related to any of the other needs of the high school science teachers or their measured professional traits.

TABLE II

ITEM	K-6 Av	K-6 %	7-8 Av	7-8 %	9-12 Av	9-12 %	7-12 Av	7-12 %
1)Computer workshops-technical use, software listings	1.7	50	1.8	67	2.1*	69	2.0	68
2)Update of technological devopments in all areas of science	0.8	23	2.2*	50	1.4	48	1.6	48
3)Listing of free materials/inexpensive/loan of materials	1.8*	56	1.7	42	0.6	24	0.8	28
4)Listing of new teaching tecnniques:innovations, integration of subject areas	0.7	19	1.9	50	1.4	38	1.5	41
5)Listing of special demonstrations available in various science disciplines	1.3	46	0.6	25	1.6	43	1.4	39
6)Speakers from various [illegible]	[illegible]	[illegible]	0.7	25	1.1	36	1.0	33
7)Obtaining classroom [illegible] for enrichment	1.5	56	1.0	42	1.0	33	1.0	35
8)Listing of suggested student science activities for independent study	0.9	31	0.6	17	1.3	43	1.1	37
9)Listing of science related curricular materials	0.6	23	1.0	50	0.7	26	0.8	32
10)Field trips-guide to sites suitable for K-12 science classes	1.1	44	0.4	17	1.2	33	1.0	30


Field Trips
List of Multi-Media Resources
List of Special Demonstrations
Highest Degree Earned
List of Special Mat'l/Equip.
List of Free Materials
Areas Now Teaching
Areas Have Taught
Level Now Teaching
Level Have Taught
Help From Qualified Advisor
Update Technol. Dev.
Teaching Techniques
Years Teaching Experience
Supplemental Materials
Sci. Activities for Ind.Study
Computer Workshops
Speakers From Various Fields
List of Tchr.Exchange Progs.
Classroom Mat.-Enrichment
List of Sci.Related Curr.Mat.
Compil. of Lesson Plans
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
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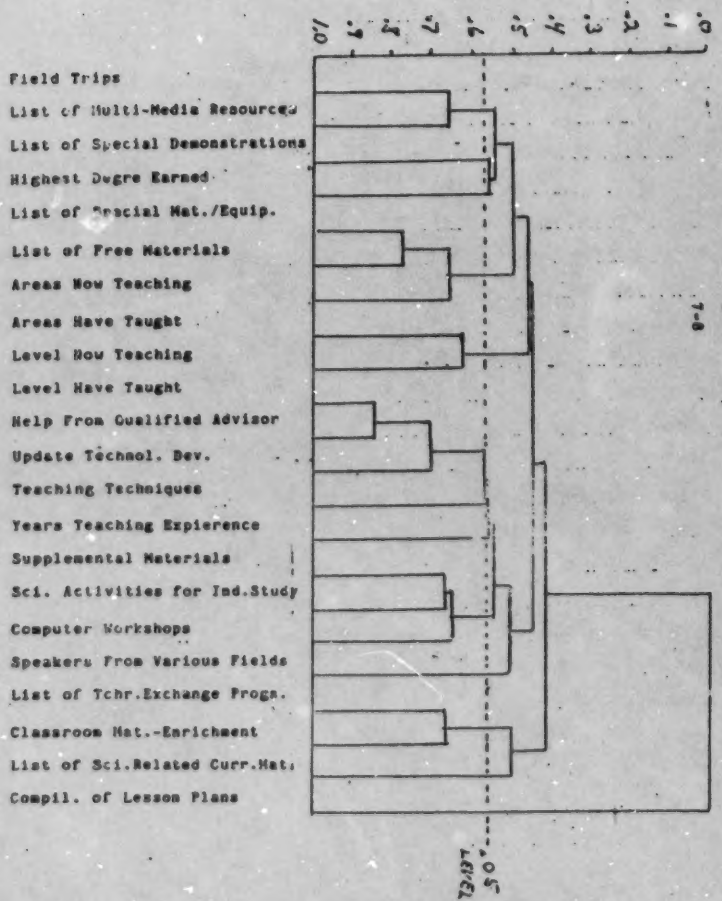

Figure 1
T-8

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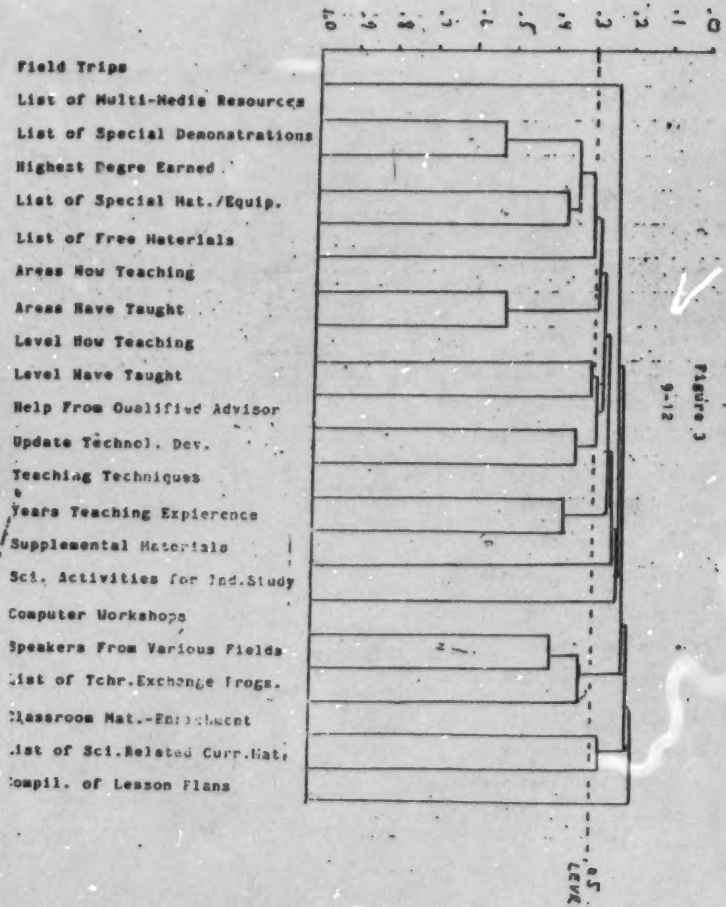
Field Trips
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Classroom Mat.-Enrichment
List of Sci.Related Curr.Mat.
Compil. of Lesson Plans
.05 LEVEL

Figure 3
9-12

Mr. WALGREN. That spirit is contageous.

Mr. BATEMAN. Thank you very much, Mrs. Konrad.

The next panelist is Dr. John DeBlasio.

Dr. DEBLASIO. I am a math teacher from Upper St. Clair and I teach senior level students in mathematics and computer science. Most students, however, are not seriously concerned about their school work. Their major efforts are devoted to after school jobs and extracurricular activities. Our students rank No. 1 in the world as fast food employees, clerks in stores, and amateur athletes and entertainers. This ranking is understandable because that is where students devote their time and efforts. Schools have become social institutions rather than academic institutions.

The number of potential distractions to learning has increased tremendously over the years. Television, video games, the quick fame of entertainers and athletes who gain success easily, lotteries which create millionaires, these things contribute to an attitude which doesn't favor daily and consistent effort.

I think you are very wise in your remarks earlier about your change in the work effort is very true. We have a great deal of effort spent by teachers in getting students to do homework assignments. It is quite difficult.

So in terms of improving the attitudes of the population toward education, I think that it is very nice, but you can't make education more important by proclamation. Some changes must occur. I think we must provide some sort of definite change.

One remark I heard earlier was attitude toward curriculum was mentioned. We did these curriculum changes awhile ago and should we do them again. Yes, sir, most certainly we should do them again. We have to do these things from time to time. We must revise and update the curriculum and the things that students are taught. Education is traditionally about 20 years behind the times. If we could do something to bridge that gap it would be very helpful.

For instance, we have textbooks that don't even acknowledge the idea of transisters and new electronic advancements.

So I have made a list of what I think could be improvements that are reasonable and things that could be done to help out.

First is the school day should be an academic experience. Students miss classes for plays, golf tournaments, et cetera. Classes should be the only activity in a given time period. Maybe the academic school day would last from 8 to 12 and then everything else would occur after that. All extracurricular activities should occur after school hours.

Don't expect teachers to simply add on new duties. Reduce the teacher-student ratio, release teachers from nonprofessional, nonacademic tasks, put teachers in learning centers and require teachers to have master degrees.

I have a kind of a nice position in my school. I have a full load like all the other mathematics teachers, but I have a choice of where I can spend my time. So I spend approximately three periods per day in the computer center. If we had a situation where teachers were available for students that they would come around and hang around an educational place and pick up a lot of information.

Develop a master teacher program for each academic discipline where selected teachers observe and assist others. An exchange program between elementary and secondary teachers could also be beneficial. Perhaps elementary teachers should teach subjects in a specialized area such as math or science.

Make computer-enhanced learning a required course objective. Each school building should have a computer classroom available. At least five microcomputers should be available in individual classrooms. Continued inservice and updating of computer knowledge should occur throughout the year with concentrated activity during the summer. Each school needs at least one full-time resource person to keep teachers informed about computer-learning materials and equipment.

Revise the curriculum to update course material. Remove topics that are obsolete or unnecessary. This activity could take place in the summer with a massive revision of course content.

Success in school must become more desirable to students. The quality of learning must be raised to a much higher level. Educators are saddened when students do not take advantage of all the potential there is for learning.

Our sporadic concerns in education also contribute to students' lack of enthusiasm. We have to be more consistent with our concerns and priorities. Every 20 years, we have to make a major push to bring schools up to a new level of efficiency. Like our students, we need a continuous effort.

Thank you.

[The prepared statement of Dr. DeBlasio follows:]

REMARKS ON

PROSPECTUS

Hearing on Math and Science Education at
Primary and Secondary Levels

Pittsburgh, PA
February 10, 1984

FROM: John DeBlassio
Mathematics and Computer Science
Upper St. Clair High School
Upper St. Clair, PA 15241

PROBLEMS

Most students are not seriously concerned about their schoolwork. Their major efforts are devoted to after school jobs and extra curricular activities. Our students rank number one in the world as (1) fast food employees, (2) clerks in stores and (3) amateur athletes and (4) entertainers. This ranking is understandable because that's where students devote their time and efforts. Schools have become social institutions rather than academic institutions.

The number of potential distractions to learning has increased tremendously over the years. Television, video games, the quick fame of entertainers and athletes who gain success easily, lotteries which create millionaires...these things contribute to an attitude which doesn't favor daily and consistent effort.

SUGGESTIONS FOR IMPROVEMENT:

1. The school day should be an academic experience. Students miss classes for plays, golf tournaments, etc. Classes should be the only activity in a given time period. All extracurricular activities should occur after school hours.

2. Don't expect teachers to simply "add on" new duties. Reduce the teacher-student ratio, release teachers from non-professional, non-academic tasks, put teachers in learning centers and require teachers to have Master Degrees.
3. Develop a Master Teacher program for each academic discipline where selected teachers observe and assist others. An exchange program between elementary and secondary teachers could also be beneficial. Perhaps elementary teachers should teach subjects in a specialized area such as math or science.
4. Make computer-enhanced learning a required course objective. Each school building should have a computer classroom available. At least 5 microcomputers should be available in individual classrooms. Continued inservice and updating of computer knowledge should occur throughout the year, with concentrated activity during the summer. Each school needs at least one full-time resource person to keep teachers informed about computer learning-materials and equipment.
5. Revise the curriculum to update course material. Remove topics that are obsolete or unnecessary. This activity could take place in the summer with a massive revision of course content.
6. Success in school must become more desirable to students. The quality of "learning" must be raised to a much higher level. Educators are saddened when students do not take advantage of all the potential there is for learning.

Our sporadic concerns in education also contribute to students lack of enthusiasm. We have to be more consistent with our concerns and priorities. Every twenty years, we have to make a major push to bring schools up to a new level of efficiency. Like our students, we need a continuous effort.

Mr. BATEMAN. Thank you, Doctor.

The concluding member of the second panel is George Murphy of the Pine-Richland High School.

Mr. MURPHY. Thank you very much. It is a pleasure to be here.

There certainly is a lot to say about education today. Probably more so in the last 3 years than previously. Since the so-called math revolution in the late fifties and early sixties, I can't think of a single day that I don't pick up my little country newspaper and read something that tells us that we have got some more changes to make.

I don't doubt a bit that we need to make some changes. I work in a small school. We have a little less than 2,000 students. At one time we had nearly 3,000 students (about 12 years ago), but like so many schools today our enrollment has dropped some. It has been projected that we will have about 1,700 students and graduate about 150 students a year between the years 1989 and 1990.

Our school makes, I think, a strong effort toward providing a good educational program for the students that we have. It is very costly. We don't have much industry. We don't have much in the way of commercial ventures in our district. Probably the greatest percentage of our tax revenue comes from the individual homeowner and the burden is quite heavy, I understand. I don't live there, but I think people find that it is very costly.

And when I think about what we face in the way of changing the curriculum and inservice education and adding computers to our classrooms, what costs we have incurred so far, I really wonder where we are going to get all the money. I know that this is not a time to ask the Federal Government for funds. It is very difficult for everybody these days and there are many, many priority items, but we do face a very serious problem in the schools. I think in my written remarks my first remark was about the amount of time that is needed for teachers to do the job and that is a thing that I have heard each person say here today.

We are probably just at the limit of what we can do as individuals in the classroom. We have many, many extra duties, most of us, and it is necessary to do most of the things that we have to do to support the school program, but I really think we are coming to a time when we may have to look for other ways to cover the duties besides the teaching duties that the teacher has.

I was to the doctor within the last 3 or 4 days. I noticed a small thing. He is very qualified and he is an excellent person and I like him a lot, but when it came time to take my blood pressure he stepped out of the room and the nurse came in and took it.

Now, I am not a doctor and I don't contend that I should not take blood pressures and things analogous to that, but I notice that while she was doing that he went and did something more in line with his speciality. I think, perhaps we need to look at that in education, to more efficiently use teaching staff on the things that they should be doing.

Many things went through my mind when I thought about what we could discuss here today. I tried to think of the things that you might really be able to help us do something about and one of them might be to find some way to help us manage time better.

I think one of the things that may help us do that is the introduction of computerized equipment for the handling of some of our administrative tasks. In our school district, we don't use a lot of computers for administrative tasks and clerical things, but in others they do and it would certainly be something, I think, within today's marketplace that we should be able to look at.

I don't think that going over computerized assistance in those areas will be cheap. We have added some computers in our school for the teaching of programming. We intend to add some for the teaching in computer literacy courses next year. We have some use for instructional purpose in our business department and we have some in our physics lab that are used for solving problems and for writing programs to solve those problems and I can tell you that just the reasonable amount of equipment that we have, which would not be excessive in any way, we have spent probably in the neighborhood of $50,000. We have the need to project next year $12,000 to $15,000, maybe $20,000 more to enlarge on this and we are not talking about a great step here. We are talking about a reasonable response to what people expect to have in their schools today.

So, I don't know that when you talk about the school district that I work for, where 1 mill of tax brings in about $60,000 and we have 70 mills of tax on property value now and the majority of our tax base is composed of homeowners, I am not sure that we have not reached near the limit of what the homeowner can pay.

I know we can always pay more, but I think people are beginning to resist that a bit.

Congressman Walgren addressed something that has really concerned me since I heard about it. I don't know where the media was or where I was, I had better say that. I don't remember hearing it in the evening news about the Soviet advances in education. They are startling. When I read about them in the journal that I get, the report from Prof. Isaac Wirzup of the University of Chicago, perhaps you gentlemen are aware of that. I was not, but he explained that in 10 years—the Soviets I believe have a 10-year school system—and within the last 10 years they have created a system in which 98 percent of their students take mathematics through 2 years of calculus. I think you also said 5 years of physics, 4 years of chemistry, 5½ years of biology, 5 years of geography—I think geography is a much neglected subject in our schools—and a year of astronomy and they did that in the last 10 years and he felt that was a mobilization of the entire population in education toward the technical sciences that would give them a much larger pool of people from which to draw for a new kind of society.

I am not saying that we should be like the Russians, but I think it is certainly true that they are the greatest adversary that we face in the world; if that is what they are doing, I think we have to wonder what they have in mind.

Another thing I read recently was that per 10,000 people of population in the country of Japan there were 400 engineers and scientists educated. In the United States it is 70. In Japan they educate 3 accountants and we educate 40. They educate 1 attorney and we educate 20.

Twenty-one percent of the Japanese population become engineers or scientists, 8 percent of ours. Thirty-five percent of Soviets and 37 percent of the West Germans.

Now I have been very fortunate in my teaching assignments over many years. I have really wonderful students. I have had some foreign exchange students and they are not all superpeople, but they certainly are dedicated in many, many ways.

Many years ago we had a German student who could not go to the dance because he had to stay home to study because he was representing his country. He did not want to do anything frivolous because he might take away from what he was learning.

I had a Japanese student about 2 years ago and she was really a wonderful, wonderful student. And I asked her one time, "In Japan are you considered an excellent mathematics student?" She was running me a little ragged in terms of things I had to do to keep up with her.

She said, "No, in Japan I am such a poor math student in fact that I will have to go into literature. I will not be able to major in mathematics or science because I am not that good."

I can remember some remarks she made. She went to the university school supported by the university. Money is not everything I realized when I heard her say that she can remember taking her examinations, which are very important there, without passing those exams—she said her hands were so cold she could scarcely write. She said they did not turn the heat on until February and the temperature is much like it is here. I thought that was incredible.

Our schools—in 1976 and 1977, when we had to close the schools we did keep some other things open but you will recall we closed down and turned the heat back and it did get cool in the buildings and it was unpleasant and people complained. I cannot imagine the situation this girl must have had.

I can remember her getting a letter from her friend when her friend did not pass the exam to go on to the university for the program she wanted and she had 1 more year to try to make it. If she did not make it then I am not sure what would happen.

I think it has been said that the greatest difference between European education and American education is that in America our education is geared to minimize the failure of many. But in European education it is geared to maximizing the success of a few.

And that may be because in the past we have had abundant resources to devote to education. We have never really been in the position we are in today which is we are being forced to make priority decisions about what we will spend the U.S. dollar on.

In European countries and Asian countries I think they have always had to do that and that may have led them to the system that they have had which is extremely competitive and requires a student to perform at tremendously high individual levels before he can be passed on.

I might also mention that she told me that in Japan, and I think I might have these figures wrong, but I think there were 63 prefectures, that I think would be akin to States here. Each one has their own medical school. She said they have an extreme abundance of

doctors coming out and that, "We would not have to be concerned about a shortage of physicians in our country," she thought.

I don't know what the Congress can do to help us. We have a need for time for teachers. That is important, but I really don't know what you can do about that except hire more help and that costs money. I don't know what you can do about our computer situation except as a definition of what computer use will be needed in the schools is defined the more thoroughly you may be able to help us with that.

Beyond that I am not certain. There is one other large problem that has been surfacing and I am quite concerned about that and that has to do with streamlining of the mathematics curriculum. I heard Dr. DeBlasio say removal of obsolete topics in science and that is also true in mathematics. I can think back to things that I taught when I first started to teach college, algebra and trigonometry, topics that we no longer teach.

In those times it was fairly easy to tell what you would not need in the curriculum anymore. When I first started to teach there was a great amount of Federal interest in supporting programs. It would be fine, a new curriculum in mathematics so we could easily see from the printed terms that were available what was being suggested and many schools tried to teach those new topics and that meant deleting some.

There were some failures in those things. I can remember when our school tried to teach algebra with trigonometry credit included in that course and we were successful for a while, but there was a certain amount of public concern about the amount of pressure on the students so we went away from that.

I think there is a need to streamline the math curriculum, probably also the science curriculum. What changes will occur probably are not going to be decided by individual teachers in the classroom. They will be decided by commissions, I presume, and by people at levels in education above mine.

All that I hope is that they will make it clear to everybody what they are going to do and when they are going to do it and particularly the testing institutions because I really don't want to live through the situation that we have had from time to time in which the curriculum has changed but the tests have not.

Now the tests change and the curriculum changes again and it may lead to a misinterpretation of the ability of our students rather than their background and I think that is probably not something that is necessary for us to have a problem with that.

I hope that the people who will take the lead in curriculum change will do everything they can to keep it well advertised so that we all know what is going to happen.

In one other area I have seen one thing that looks very promising to me and I will mention it to you. It is from the November 1983 journal, a 2-year college math journal, and it was written by Mura Hatiba from the Tel Aviv University regarding the study she did at Stanford University. It was after all these years the first thing that I had seen that told me specifically things that I could do in the mathematics classroom to improve the delivery of the context that I was hoping to get to my students. And the title of the topic was "What Makes Math Lessons Easy to Follow, Under-

stand and Remember," and it was a very interesting study and I think it is something that probably needs to be read by everybody in the field of mathematics today.

I don't know what else we could talk about today from my standpoint. There are tons of things to mention, but I think I have probably taken more time than I really should.

Thank you very much.

Mr. BATEMAN. Thank you, Mr. Murphy.

TESTIMONY

BEFORE

THE

SUBCOMMITTEE ON SCIENCE, RESEARCH, AND TECHNOLOGY

OF THE

HOUSE OF REPRESENTATIVES

OF THE

UNITED STATES

10 FEBRUARY 84

BY

GEORGE R. MURPHY

MATHEMATICS DEPARTMENT CHAIRPERSON

RICHLAND HIGH SCHOOL

PINE-RICHLAND SCHOOL DISTRICT

GIBSONIA, PENNSYLVANIA

15044

I am George Murphy, Chairperson of the Mathematics Department of Richland High School in the Pine-Richland School District. Our district is located about 18 miles from Pittsburgh in Northern Allegheny County, and has been described as being primarily residential/rural.

Pine-Richland presently serves a total of 1965 students in grades K-12: 769 in three K-5 elementary "neighborhood" schools; 475 in a "middle" school for grades 6, 7, and 8; and 750 in a grade 9-12 high school. There are approximately 175-200 additional school-age children who live in the district but who attend private, parochial, or special schools.

It is true with many school districts today, we are experiencing "declining enrollments" from our previous high of about 3,000 students in the early 1970's. Our present senior class has 173 members, the junior, sophomore, and freshmen classes have 200, 194, and 183 members respectively. However, our first grade class has only 130 students.

It is currently projected that in 1989-90, our enrollments will stabilize at approximately 1700 students K-12 with about 135 students in a typical graduating class.

Our superintendent, Dr. Stephen Storkel, has undertaken several initiatives designed to promote the positive aspects of our school district in order to try to reverse these "declining enrollments." Perhaps the most unique of these is the formation of a "Community Council" consisting of the boards of the school district and of each of the two townships that make up the school district.

The "Community Council" was formed to address problems of a common concern to all three boards. This is a new venture, but regular meetings have produced interest in obtaining water and sewage projects in order to make area land more attractive to prospective home-builders. In addition, there is interest in sharing costs to provide common services in a community library, a computer facility, and a tax-collection agency.

A "Teen Center" was recently opened under the auspices of both townships in a recently closed elementary school, and all 3 boards are considering sharing equally the cost of a "human services coordinator", something they could not afford alone.

It should be mentioned that our district is largely residential with a few small industries and some small commercial districts. The schools provide the focus for activities involving youngsters, and the majority of tax support for the schools comes from individual homeowners.

The total value of our district's real estate is approximately $38,657,430. with another $3,000,000. currently in litigation over the right to tax St. Barnabas Village, a senior-citizen apartment complex. At the present rates, one mil of real estate tax yields about $63,000. and a total of 75 mils is imposed. In addition, the district levies various other taxes, including per capita taxes, real estate transfer taxes, and a wage tax. These currently produce about $500,000. in revenues.

Our K-5 elementary school program includes the study of science and mathematics as a part of the required daily instructional program. In grades K-3, we have self-contained classrooms in which math and science topics are taught by the regular classroom teacher. In grades 4 and 5, those topics are taught by "specialists" in a semi-departmentalized setting.

During these years, the mathematics taught is best described as the "conventional topics of arithmetic" and the science presented consists of introductory topics from general science.

In the "middle-school" we have fully departmentalized instruction in both math and science. All students are required to take 1 course in mathematics as well as 1 course in science in each of the grades 6, 7, and 8.

Provisions for students with special abilities and interests include a math clinic in grades 6, 7, and 8 for students who need additional help in acquiring basic skills. Also, there is the annual placement of a group of interested and able students into a course in first year algebra in grade 8. (Students do not usually begin their study of first-year algebra until grade 9 in most schools.)

During their 4 years of high school, students are presently required to successfully complete 2 credits in science and 2 credits in mathematics in order to graduate. These requirements have been in effect for many years.

Beginning in 1985, all entering freshmen will be required to accumulate 3 credits in math and 3 credits in science to qualify for a diploma. The first students to graduate under these requirements will be members of the Class of 1989.

Our science department offers a total of 13 sources from which a student may select his required 2 credits. During this year, we find 509 students enrolled in 13 science courses taught by 6 full time teachers.

Although students are presently free to select any science source in order to fulfill graduation requirements, beginning in 1984-85, all students will be required to take a 1 credit course in biology. Present plans include the introduction of 2 additional courses for 1984-85: "Contemporary Earth and Space Science" and "Contemporary Biology" which will be directed to students of below-average performance in science.

Similarly, the mathematics department offers 21 courses for graduation credit. They are aimed at the wide divergence of abilities and interests among our student-body and include courses from basic math through calculus. This year there are 555 students enrolled in 15 math courses taught by 5 full time and 1 part time instructor.

Offering such a large variety of courses in a small school creates some difficulties for the instructional staff and for the administration, but the benefits to students are thought to outweigh the costs.

The main goals of our math curriculum are to:

1. provide adequate courses for all students consonant with their abilities and interests; and
2. provide every possible, reasonable chance for students to obtain the skills of algebra and geometry, without which they may find entry into future careers and further education difficult, if not impossible.

Detailed information about our math and science curricula is provided in the attachements from our most recent high school program of studies.

MATHEMATICS

Recommended minimum prerequisites for high school math courses have been established. They represent a strong indicator of possible success in that specific course. For these reasons, students who take courses for which they do not meet the recommended prerequisites, or who take courses out of the suggested sequence, or who change programs are required to have a parent signature on the scheduling form at time of course selection.

Essentials Program	Career Program	Fundamentals Program	Liberal Program	Academic Program	Accelerated Program
General Math		Pre-Algebra Math	Courses are selected from either the Acc'l.	Algebra 1	Accl. Algebra 1
	Business Math	Fundamentals of Algebra 1	or	Geometry	Accl. Geometry
	Vo-Tech Math	Fundamentals of Geometry	Acad., however, a full four year Math sequence is usually not taken	Alg.2	Accl. Alg. 2
Senior Math		Algebra-Geometry Review	Intro. to Analysis w/Trig.		Accl. Trigonometry w/Intro. Analysis
					Accl. Introductory Calculus
	Basic Skills Program Foundations of Math 1,2,3,4		Probability and Statistics		
			Introductory Computer Programming		

BASIC SKILLS PROGRAM

This Math Program is designed for students who have demonstrated a deficiency in basic math skills and fundamental operations. Students who score poorly on a test administered by the staff will be enrolled in this program. Students will have an opportunity to test out of this program when they can demonstrate a mastery and comprehension of the basic math skills and fundamental operations.

Various credits will be given upon completion of program and will be recorded as Foundations of Math 1, 2, 3 or 4.

The following chart describes the science courses available in grades 9 through 12. All students must pass two science courses totaling 2 credits in order to meet the graduation requirements.

Courses should be appropriate to the student's post-high school plans and may be selected from the following offering.

9th Grade	10th Grade	11th and/or 12th Grade
Earth & Space	Earth & Space	Earth & Space
Accl. Earth & Space	Accl. Earth & Space	Accl. Earth & Space
Accl. Biology 1	Accl. Biology 1	Accl. Biology 1
	Biology 1	Biology 1
	Accl. Biology 2	Accl. Biology 2
	Chemistry 1	Chemistry 1
	Accl. Chemistry 1	Accl. Chemistry 1
	Physics 1	Physics 1
	Accl. Physics 1	Accl. Physics 1
		Accl. Physics 2
		Accl. Chemistry 2
		Physical Science**
		Conservation & Environment**

**Semester Courses

Earth and Space - Grades 9, 10, 11, 12

This course is designed to provide the student with a better understanding of the earth, its systems and its place in the universe. Emphasis is placed on the physical laws of nature and the effects that they have on our surroundings.

The course is divided into four areas of study: astronomy, geology, meteorology and oceanography. The topics covered will include: atomic structure, origins of the universe, stellar evolution, the solar system, the sun, the moon, minerals, rocks, weathering and erosion, soil formation, earthquakes, plate tectonics, geologic history, structure of the atmosphere, energy transfers, weather forecasting, ocean salinity, tides and currents and ocean structures.

A variety of laboratory investigations are conducted to reinforce the concepts studied and to introduce the student to basic laboratory procedures.

1 credit — No Prerequisite

Accelerated Earth and Space - Grades 9, 10, 11, 12

This course is designed for those students who intend to continue with the chemical and physical sciences. Accelerated Earth Science will cover the same general topics as listed under regular earth science, with topics covered in more depth and with chemical and atomic relationships stressed. In addition, field studies will be provided. Students will be expected to conduct independent research projects.

1 credit — Prerequisite: At least a "B" in previous science course and teacher recommendation.

Biology 1 - Grades 10, 11, 12

This basic course is designed to help pupils better understand their environment. Emphasis is on the scientific method through a consideration of plant and animal life. Genetics, conservation, ecology and classification are some of the topics of study. Laboratory work involves animal and plant dissections and demonstrations.

1 credit — No Prerequisites

Accelerated Biology 1 - Grades 9, 10, 11, 12

This course is designed for the academically motivated student. Areas of study will include: cytology, behavior of organisms, anatomy and physiology of plants and animals, genetics, microbiology, and ecology.

1 credit — Prerequisite: At least a "B" grade in previous science course and teacher recommendation.

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(18)

MATHEMATICS - continued

Accl. Introductory Calculus - Grade 12

A very brief review of some basic pre-calculus material followed by the study of the elements of calculus. Topics include: limits of functions, derivatives, curve sketching, and integration.

1 credit

Recommended Minimum Prerequisites: "C" or better in Trigonometry and Introductory Analysis* or in Introductory Analysis with Trigonometry.

Probability and Statistics - Grades 11, 12

A one semester course on the fundamental concepts of Probability and Statistics. The topics of random variables, probability distributions, statistical measurement and decision making, are presented by using the mathematical terms and problem solving techniques of high school algebra.

1/2 credit

Recommended Minimum Prerequisites: "C" grade or better in Algebra 2

Computer Programming 1 - Grades 11, 12

A one semester course which covers computer terminology, flow charts, program writing and problem solving via computer programs. Hardware includes the Monroe 1880 Scientific Programmable Printing Calculator/Computer and the TSR-80 Micro Computer. There will be limited enrollment.

1/2 credit

Recommended Minimum Prerequisites: "B" grade or better in Algebra 2

Computer Programming 2 - Grades 11, 12

A continuation of Computer programming 1.

1/2 credit

PRACTICAL ARTS

The Home Economics and Industrial Arts Departments offer co-educational semester and full year courses. In Home Economics, several courses may be taken simultaneously.

The Practical Arts Program is designed to provide students with a better understanding and appreciation of our technological society. Homemaking, consumer, vocational and avocational learning experiences are stressed.

MATHEMATICS - continued

ACCELERATED PROGRAM

The program rationale is to provide the student who has a better-than-average background in mathematics with the thorough study of those topics recommended for career preparation in which quantified data must be fully understood and skillfully handled. This includes mathematics, science, and technology that may require work beyond the bachelor's degree.

Emphasis is on theory as well as on the manipulative skills that such students usually master with ease. In addition, earlier and continued use of abstract symbolism occurs in reading and written work. Students are encouraged to make some difficult proofs on their own.

Accl. Geometry - Grade 9

The study of the familiar topics of geometry but from the standpoint of transformations. This should provide background for those who expect to study linear and vector algebra, and the structure of mathematics in the future.

1 credit

Recommended Minimum Prerequisites: "C" grade or better in any first-year Algebra course. "C" average or better in any sequence of first and second year Algebra. "B" average or better in the PAM - PAO sequence.

Accl. Algebra 2 - Grades 10, 11, 12

Continued work with the axiomatic approach begun in Acc'l. Algebra 1. Provides the breadth and depth of topics necessary for these students. Very closely follows Acc'l. Algebra 1.

1 credit

Recommended Minimum Prerequisites: A grade of "C" or better in any first year Algebra course. "C" average or better in a combination of first year Algebra and a Geometry course. An average of "A" in the sequence PAM - POA and PG.

Accl. Trigonometry and Introductory Analysis - Grades 11, 12

The topics of trigonometry are covered first to better fit the placement of physics in the student's course sequence. There is strong emphasis on circular functions, analytic trigonometry and inverse circular functions. The course continues with topics from advanced algebra and/or pre-calculus mathematics. Note: Students wanting credit in trigonometry only are asked to make arrangements through the counselors to enroll in TIA with the written intention of withdrawing upon their successful completion of the first semesters work in TIA which will include trigonometry.

1 credit

Recommended Minimum Prerequisites: "C" grade or better in Algebra 2 or Acc'l. Algebra 2.

MATHEMATICS - continued

Algebra 1 - Grades 9, 10, 11, 12

The acquisition and application of the skills necessary for the solution of elementary equations, especially linear, with some beginning work on quadratic equations.

1 credit

Recommended Minimum Prerequisites: A grade of "C" or better in 8th grade Contemporary Math 2. A grade of "A" in General Mathematics.

Geometry - Grades 10, 11, 12

The formal study of axiomatics and proof-making in which idealized physical space is used as a model.

1 credit

Recommended Minimum Prerequisites: "C" grade or better in any first-year Algebra course. "C" average or better in any sequence. Students with "D" grade in an Algebra course should probably enroll in Fundamentals of Geometry.

Algebra 2 - Grades 10, 11, 12

A continuation of Algebra 1, but with emphasis on the skills required for the solution of quadratics, with possible work on equations of degree greater than two.

1 credit

Recommended Minimum Prerequisites: "C" grade or better in any first-year Algebra course. "C" average or better in any combination of a first-year Algebra course and a Geometry course. "B" average or better in the sequence PAM-PAO and PG.

Introductory Analysis With Trigonometry - Grades 11, 12

The study of symbolic logic and abstract algebraic systems. The reinforcement of selected topics from algebra; and the study of trigonometry with an emphasis on circular functions.

1 credit

Recommended Minimum Prerequisites: Grade of "C" or better in Algebra 2 or Accl. Algebra 2

MATHEMATICS - continued

Fundamental of Geometry - Grades 10, 11, 12 continued

1 credit
(Equivalent in value to any other Geometry offered)

Recommended Minimum Prerequisites: "D" grade or better in Fundamentals of Algebra 1. "D" grade or better in Algebra 1. "D" average or better in a sequence of first and second year Algebra

Algebra-Geometry Review - Grades 11, 12

Reinforces those areas of importance in both algebra and geometry for those students who may have had difficulty in their previous course work, or who may lack confidence in their ability to handle such material. Also helpful to those students who seek improvement in certain standardized tests such as the SAT or various state/federal civil service exams.

1 credit

Required Minimum Prerequisites: Must have completed any one-year Geometry course

LIBERAL PROGRAM

The Liberal Program is not really a separate program. Students who take the Liberal Program simply terminate their study of mathematics after two full years of Algebra and a year of Geometry. See the notes on the table.

ACADEMIC PROGRAM

The present day version of "College-prep Program". It is designed for the typical student with an average background who wants to prepare for college. The program rationale is to provide the student who has an average background with the minimum skills normally required to prepare for a career in which quantified information must be delt with. This includes to a varying degree, the physical, life, management, and social science as well as most technical studies and liberal arts.

In the earliest courses most emphasis is on manipulation and problem-solving. As the students progress, moderate emphasis is placed on axiomatic and abstract symbolism. As with nearly all mathematics programs today, there is emphasis on the structure of the real number system, but students are more often required to follow difficult proofs than to make them independently.

Algebra 1 - Grades 9, 10, 11, 12

The acquisiton and application of the skills necessary for the solution of elementary equations, especially linear, with some beginning work on quadratic equations.

1 credit

Recommended Minimum Prerequisites: A grade of "C" or better in 8th grade Contemporary Math 8. A grade of "A" in General Mathematic

MATHEMATICS - continued

Business Math - Grades 10, 11, 12

See the Business Department section.

Votech Math - Grades 10, 11, 12

A one-year course in which about one semester is devoted to a review of basic math skills and the development of simple algebra, geometry and trigonometry topics. The second semester includes the study of the specific math skills in some of the job categories for which materials are presently available, such as: automotive, carpentry, electrical, machinist, masonry, office work, printing, sheet metal, welding and nursing.

1 credit — No Prerequisite

FUNDAMENTAL PROGRAM

The program rationale is to provide the student who may have a somewhat less-than-average math background the opportunity for successful acquisition of skills and courses without which his future possibilities may be seriously hampered. Future training, should he need or desire it, might be difficult or even nearly impossible to access without the minimum background available in this program.

There is a strong emphasis on numerical problem-solving with a minimum of theory. In addition, there is substantial drill and review in these slower-than-average-paced courses.

Pre-Algebra Math - Grades 9, 10, 11, 12

The first year of a two-year sequence of courses which together provide adequate background in the topics of Algebra 1. Approximately one-half the units in the typical Algebra 1 course are covered in PAM.

1 credit — Recommended Minimum Prerequisites: "D" in 8th Grade Contempory Math, "C" in General Math

Fundamentals of Algebra 1 - Grades 10, 11, 12

This full year course closely follows PAM. In this one-year course, the topics normally covered in the second half of a regular Algebra 1 course are presented. FOA carries full Algebra 1 credit.

1 credit (equivalent in value to a course in first-year Algebra) — Recommended Minimum Prerequisites:

Fundamentals of Geometry - Grades 10, 11, 12

Provides opportunity for credit in the study of geometry with the absolute minimum justifiable amount of proof-making and reading. Emphasis is on numerical applications.

MATHEMATICS - continued

ESSENTIALS PROGRAM

The program rationale is to provide a normal classroom setting for the student who may typically have some difficulties in mathematics; who may be undecided about career plans; or who may be fairly certain that he will not seek employment in which math skills will be generally important.

The courses traditionally contain considerable review of basic computation skills with attendant development of skill deficiencies. Often other math-related topics from "real life" are presented as a way to show the usefulness of mathematics.

General Math - Grade 9

The course is designed to reinforce the computational skills of arithmetic and to apply the use of those skills to everyday life.

credit — No Prerequisite

Senior Math - Grade 12

A course for students who need a credit for graduation and who may need additional reinforcement in the basic computational skills as well as in formulas for area and volume, some uses of signed numbers and metric measure.

1 credit — Required Minimum Prerequisite: Must have completed at least one math course in either grade 9, 10, or 11. Students with a Geometry background may not elect this course.

CAREER PROGRAM

The program rationale is to provide opportunities for students with varying backgrounds to study the mathematics that applies to the specific career areas of their interest. Also to provide the math skills needed for success in trade and vocational schools and apprenticeship training as well as entry-level job skills for those who anticipate no additional schooling in the near future.

The review of basic computational skills and the extension of those skills to such additional topics as may be required in the job areas of interest to the student are some of the program goals. They also include the study of the math skills recommended as being directly job related to specific work categories; to intensify the development of work habits such as attendance, responsibility, etc.

Accelerated Biology 2 - Grades 10, 11, 12
(6 periods per week)

An enrichment course designed for students who may wish to continue biological science studies in college or technical schools. Course includes comprehensive intensified studies in evolution and ecology, cellular biology, biochemistry, genetics, and plant and animal physiology. Laboratory investigation will be used to reinforce the various areas of study. A minimum of four mini research papers will be required.

1 credit

Prerequisite: "B" in Biology 1 and have completed or be enrolled in Chemistry 1.

Chemistry 1 - Grades 10, 11, 12
(6 periods per week)

Chemistry 1 is designed to provide a general survey of the principles of both inorganic and organic chemistry, and the application of these principals. The topics covered will include: uncertainty in measurement, elements, compounds, atomic structure, Periodic Law, chemical bonding, chemical composition, chemical equations, nomenclature, Kinetic Molecular Theory of Gases, Theory of Ionization, Stoichiometry, acid-base theory, pH, hydro- equilibrium, oxidation-reduction.

Strong emphasis is placed upon the use of mathematics in the development of chemical principles and the application of these principles. Laboratory investigation is provided not only as a means of confirming the principles studied, but to also develop standard laboratory techniques.

1 credit

Corequisite: Accelerated Alg. 2 for 10th graders.
Corequisite: Alg. 2 for 11th or 12th graders.

Accelerated Chemistry 1 - Grades 10, 11, 12
(7 periods per week)

The topics covered in this course will be the same as those taught in the regular chemistry 1 course. However, the material will be taught at a faster pace, in a much greater depth and will involve a greater use of mathematics. There will also be more individual laboratory experimentation.

1 credit

Corequisite: Accelerated Algebra for the 10th graders. Must be in accelerated math program.

Accelerated Chemistry 2 - Grades 11, 12
(7 periods per week)

Chemistry 2 is designed to provide a more in-depth knowledge of the material covered in Chemistry 1, refine laboratory techniques, and to provide a chemistry experience which will enhance success in the study of this physical science. In addition to the topics listed as part of Chemistry 1, this course will include an introduction to; Quantum Theory, Chemical Thermodynamics, Molecular Orbital Theory, Crystal Field Theory, and Ligand Field Theory.

Strong emphasis is placed upon the use of mathematics and physics in the development and application of chemical principles. Students taking this course should have some knowledge of; vectors, exponential functions, logarithms, circular functions, and elementary physics.

1 credit

Prerequisites: "B" in Accelerated Chemistry 1 or "B" in regular chemistry and permission of the instructor.

Physics 1 - Grades 10, 11, 12
(6 periods per week)

This course meets six periods per week, including a two period laboratory session. Students are familiarized with basic concepts in forces, energy, motion, heat, waves, sound, light, electricity and nuclear reactions.

1 credit

Prerequisites: A "C" or better in Algebra 1 and one science course

Corequisite: Algebra 2 or geometry or another more advanced math course in the academic sequence

Accelerated Physics 1 - Grades 10, 11, 12
(7 periods per week)

This course covers the basic areas of physics: force, motion, energy, heat waves, light, electricity and magnetism, relativity and nuclear energy. Mathematics is used as a tool in analyzing problems requiring logical thought processes based on concepts in the above topic areas. A two period lab occurs twice weekly plus 3 periods of class instruction. (7 periods per week total) Basic calculus is studied near the year's end in preparation for Accelerated Physics 2.

1 credit

Prerequisites: "B" or higher grade in Algebra 1 and one science course.

Corequisite: Algebra 2 or geometry or another more advanced math course in the academic sequence

Accelerated Physics 2 - Grades 11, 12
(7 periods per week)

This course is a science based on a small number of fundamental concepts studied with the aid of calculus rather than a collection of areas.* Students may devise their own experiments and are encouraged to experiment intensively. Two double lab periods and three single lecture and problem-solving periods occur weekly (7 periods per week).

*Class time is divided between learning calculus and physics.

1 credit

Prerequisites: Final grade of "C" or better in Accelerated Physics 1. Final grade of "C" or better in Regular Physics 1 and permission of instructor

Physical Science - Grades 11, 12

This one semester course is a study of matter and energy. The physical and chemical properties of matter are studied as are the topics of heat, light sound, electricity, mechanical and nuclear energy.

1/2 credit

No Prerequisite

Conservation and Environment - Grades 11, 12

This one semester course meets five periods per week. The course is designed for students wishing to further their education in soil, water, plant and animal conservation. Environmental studies will include ecological system and the interdependence of organisms.

1/2 credit

Recommended Prerequisite: Biology

With regard to student achievement, our experience with the "Scholastic Aptitude Test" parallels the experience of most schools in the nation.

	AVERAGE R.H.S. SCORES		AVERAGE NATIONAL SCORES	
	VERBAL	MATH	VERBAL	MATH
1983	433	466	425	468
1982	443	475	426	467
1981	443	466	424	466
1980	432	452	424	466
1979	425	463	427	467
1978	437	469	429	468
1977	439	492	429	470
1976	441	474	431	472
1975	436	467	434	472
1974	448	491	444	480
1973	460	496	445	481
1972	449	502	453	484

Also, during the 1982-83 academic year, our superintendent, Dr. Stephen Storkel, instituted the use of the Science Research Associates Achievement Tests in all grades 1-12 in order to provide a benchmark and guide in the evaluation of our students' achievement in several areas. Results of these tests for last year are attached.

1982-83 PINE-RICHLAND ACHIEVEMENT TEST RESULTS

ELEMENTARY					
No. of Students and Grade Level	125 1st	134 2nd	117 3rd	127 4th	137 5th
99th Percentile to 76th Percentile	93	81	80	73	80
75th Percentile to 51st Percentile	14	16	19	25	27
***** National Average ******					
50th Percentile to 26th Percentile	14	15	18	25	27
25th Percentile to 1st Percentile	1	2	0	0	3
Percent of Students Above National Average	86	85	85	80	76

STUDENTS MAKE PROGRESS

Overall, approximately 75% of the Pine-Richland School District student body scored above the national average in the achievement tests administered in the spring of 1983. This is the first year in which National Standardized Tests were given to students in grade levels 1 through 12. These results will now provide a base line from which a measure of progress can be taken on each student and the total classes annually.

Having established a base line, district administrators and teachers will use the information to improve student performance, evaluate curriculum and increase the academic standards of the school district. Each year's scores will show the growth in learning taking place in Pine-Richland.

PINE MIDDLE SCHOOL			
No. of Students and Grade Level	175 6th	7th	177 8th
99th Percentile to 76th Percentile	90	71	93
75th Percentile to 51st Percentile	91	48	89
***** National Average ******			
50th Percentile to 26th Percentile	21	30	20
25th Percentile to 1st Percentile	11	11	5
Percent of Students Above National Average	82	74	84
Pine-Richland Class Average Percentile	75	69	75

The parents of each child attending school have received individual performance levels of local students.

EXAMPLE

If twelfth graders in the Pine-Richland School District scored in the 77th percentile in math, this indicates that nationally 76% of the twelfth graders, or 76 out of each 100, scored below the local students. Also, 23% of the twelfth graders nationally scored higher than Richland's senior class. This method of rating achievement can also be applied to individual students in the district as compared to their class as a whole. This is the information included on the performance profile sent to parents.

RICHLAND HIGH SCHOOL				
No. of Students and Grade Level	153 9th	153 10th	156 11th	158 12th
99th Percentile to 76th Percentile	104	87	83	85
75th Percentile to 51st Percentile	41	46	44	46
***** National Average ******				
50th Percentile to 26th Percentile	23	35	29	35
25th Percentile to 1st Percentile	14	14	10	22
Percent of Students Above National Average	68	73	76	64
Pine-Richland Class Average Percentile	74	72	72	61

"Achievement scores above the national average indicate that students are progressing but there is room for improvement until we reach the 99th percentile." According to Superintendent Stephen Starbel, "the district goal is to improve each grade's average percentile until all of our students score above the national average with no student falling below, and the Pine-Richland average moving upward steadily between the 76th and 99th percentile." The board, administration and professional staff are committed to attaining this goal to the best of our combined abilities.

SCHOOL STARTS SEPTEMBER 6, 1983

FACULTY BULLETIN

June 2, 1983

SRA TEST RESULTS

The SRA test results have arrived. Complete student profiles are available in the Guidance Office. Faculty members are invited to view these both this year and again at the start of next year. Data for each student includes national percentiles as well as grade equivalents and stanine scores for the following areas:

Reading Total	Language Arts Total
Reading Vocabulary	Language Arts Mechanics
Reading Comprehension	Language Arts Usage
Math Total	Spelling
Math Concepts	Reference Materials
Math Computation	Social Studies
Math Problems	Science

Individual student scores are being mailed to each student with the report cards in June.

The following chart gives the grade equivalent scores:

	GRADE 9	GRADE 10	GRADE 11	GRADE 12
Composite	12-0	12-9	12-9	12-9
Vocabulary	11-5	12-3	12-9	12-9
Comprehension	11-9	12-7	12-9	12-9
Math Concepts	12-9	12-9	12-9	12-9
Math Computation	12-7	No test	No test	No test
Math Problems	11-9	12-9	12-9	12-9
Language Mechanics	12-5	12-9	12-9	12-9
Language Usage	12-2	No Test	No test	No test
Spelling	11-6	11-1	12-4	12-5
Reference Skills	11-5	12-9	12-9	12-9
Social Studies	11-8	12-1	12-9	12-9
Science	12-9	12-9	12-9	12-9
Survival Skills	No test	12-8	12-9	12-9

It should be noted that 12-9 is the highest attainable score.

The following chart gives the national percentile scores:

	GRADE 9	GRADE 10	GRADE 11	GRADE 12
Composite	74	72	72	61
Vocabulary	74	70	68	58
Comprehension	75	70	70	61
Math Concepts	79	75	71	61
Math Computation	69	No test	No test	No test
Math Problems	72	75	72	65
Lang. Mech.	73	74	70	60
Lang. Usage	71	No test	No test	No test
Spelling	70	54	54	46
Reference	71	72	69	59
Social Studies	74	68	62	52
Science	78	77	76	65
Survival Skills	No test	75	73	63

The problems that I face in the classroom today relate mostly to time.

Naturally, most of my day is spent in teaching, or in doing those things that are directly related to my teaching. However, a fair amount of time is also spent in non-teaching duties. All of those duties are important to the running of a school and need to be done. I am certainly not above doing them. They are all related to students in some way.

Although some of them may best be done by teachers, I am not fully convinced th. many could not be done reasonably well by adjunct personnel at a lower cost. If that were to happen, it would free up some time that could be out to more direct classroom use.

Non-teaching duties have been part of the teacher's job since long before I entered education 25 years ago, but with the level of personal service that people have come to expect of almost all institutions in our society today, we face a serious problem. If we are to increase public support for our schools, a way must be found to permit teachers to devote a higher percentage of their work-time to delivering personal service to students and their parents.

I would say that all teachers of laboratory sciences, and here I would include computer facilities also, have a serious problem in finding time for the "care and counting" of equipment.

As a teacher, I have always accepted the reading and study that are required to keep up in my field. I must tell you that that has become a very time-consuming task in the last few years.

I am a member of both the Mathematical Association of America and the National Council of Teachers of Mathematics. I read 5 journals regularly, and normaliy attend the section meeting of the M.A.A. These are all things that I do largely at my own expense and on my own time as part of my professional obligation. Many teachers do as much or more.

Anything that can be done to reduce the time that teachers spend on clerical tasks or on non-teaching student supervision would be a great help.

Perhaps the computer seems to offer the best hope for relief from clerical duties. Such relief will probably be costly to initiate, both in time and in money, and if the end result is a system that can rapidly porduce results after the teacher enters data in a tedious and time-consuming way, I may be worse off than before.

Most of the teachers with whom I work are sincere, dedicated professionals in every sense of that word. They have a genuine concern for their students and our schools and our country, but most are so busy that they don't really have time to communicate with one another, to attempt to solve the problems of our schools, together.

One of my colleagues recently remarked: "There is only one of me, and I am doing everything I can. I couldn't do any more even if it meant the loss of my job." This from a thoughtful and reserved, hard-working, veteran teacher.

Dedicated teachers do what they do for reasons other than money. Truthfully, you could pay them a thousand dollars a day and they could not produce much more than they do now. Many shorten their lunch time in order to give additional work time. Many remain at the desk after "quitting time." Homework for the teachers of my acquaintance seems to be the rule rather than the exception.

The technology of the modern workplace has largely bypassed us. It's introduction might save us: plentiful access to copiers, to phones, to secretaries, to all of the things we see in those TV commercials, but not if it is done in a manner that requires more clerical work than we do now.

Our students suffer also from a shortage of time. When I entered teaching, few students held jobs after school. There were few activities to consume their evenings. Television was not nearly so seductive. Only a few sports were available, and those appealed to a limited group.

Today that is very much changed. Many students work. The year is filled with many good and worth-while activities: field trips, homecoming, rehersals.

All of these things are good and contribute to the growth of young people, but they take time--time out of class, and time away from studies at home. It is often difficult to find a day on which 100% attendance can be guaranteed in order to schedule a test.

I do not personally have any serious idea that these things can be much changed in our society, but the reality of their impact cannot be ignored.

The computer has 3 main roles in education:

1. clerical aide and information manager
2. problem solver
3. teacher

I have discussed item 1 to some extent. Regarding the use of the computer as a problem solver, our high school math department introduced limited computer use into some math courses over 10 years ago with the advent of small, portable, self-contained, and reasonably priced equipment. Our goal was to provide that which would help students solve problems that they encountered in their everyday course work in math and science.

Problems of economics and access limited our progress, but the well known recent developments in the field of microcomputers has enabled us to equip a classroom with adequate equipment for teaching computer programming to about 15 students at a time. Here the emphasis is on learning to write the program that the computer can use to solve a problem that itself may be used only to illustrate a necessary concept required in programming.

Next year we hope to extend this use of computers to a larger portion of our student population by the introduction of a computer literacy course. It will be aimed at providing adequate background for average students to operate computers and to run commercially-available programs on the. Programming will be taught but not at such depth as in the regular programming course.

Elsewhere, we find our physics lab equipped with such computers as can be used by students to solve problems and analyze data. To the extent that it is necessary to write programs for that purpose, the instructor teaches the class how to do so. Our business department recently purchased a system on which to run commercial programs in the area of accounting and word processing.

All of these areas will probably be expanded next year. Note that they all emphasize the use of the computer as a tool. For some, it will be important to know how to write the programs that the computer uses. For others, the ability to run already available programs will be sufficient and will give them greater understanding of the problems they are solving.

The cost of doing this is not insignificant even though it is less expensive today than yesterday. When we include the cost of our older, higher priced equipment, we find a cost for the purposes mentioned above of about $50,000, and requested expansion in these areas alone totals in the neighborhood of $15,000. to $20,000. for next year. We are not talking of a quantum leap here, just a reasonable response to the changes being required of us in one area of the curriculum.

When we come to the use of the computer as a teacher, we may find it quite difficult to afford all of the hardware and software that we will need. This aspect of computer use is only now in its beginning stages.

Many people see the computer as the key to truly individualized education. We read that the computer can have most of the attributes of a good teacher and one of the faults. The key to the use of the computer probably will be in the production of good software, which will probably be initially expensive. Schools may need help in the evaluation and purchase of such software. We don't have a lot of money to put into ventures that may not pay off as well as present methods.

There are many, many issues that could be discussed here today. I have raised two that are probably well-known. I would like to mention one other that is perhaps not as well-known, but which is very important and may prove to be very controversial. That deals with proposals to modify, change, or "streamline" the mathematical sciences curriculum.

Something must undoubtedly be done to adjust course content in math if we are to take on new topics. Old ones must give way. This has happened before but usually slowly and to only a few topics at a time. Probably the biggest change came in the 1960's with the so-called "math revolution" and the introduction of "modern math" into the curriculum.

If significant change is to come to the content of math courses, it must be fully advertised to the American public, and it must be thoroughly coordinated with the programs at colleges and universities as well as testing and evaluation institutions. These requirements, it would seem to me, would require some sort of national consensus and direction. It may be necessary for the federal government to assist in the funding of projects designed to determine the best direction, and to help in implementing the resulting new curricula. Such an undertaking is probably urgent and failure cannot be permitted.

When I left the steel mill 25 years ago to enter teaching, pick and shovel work was ending and work with payloaders was beginning. The open-hearth gave way to the electric furnace, the pouring aisle to the continuous caster.

The mills that did not change with the times are no more.

Teaching is at a crossroads. It is good to not always rush into untried things, but it is required of us to make progress. The schools have probably the greatest need to deliver personal service of any institution in our society with the exception of health care. We deal with the only true natural resource: the mind. After life itself, what is of greater importance?

Mr. WALGREN. This whole idea of whether or not there is one way to do things and how diverse that educational community is, on the State level we are doing something here and apparently in times past some teaching vehicles came from the Federal level.

It makes you wonder whether there isn't some kind of networking that could come together that would sort of fill in some of the regional clearinghouse type functions that you have had to create on a local level, elementary school teachers having some exposure to secondary school teachers and teachers being able to talk to each other to try to create enthusiasm and initiative and remarking literally.

I understand the National Science Foundation does some of these things in-service. Have any of you had any experience with a federally driven program? I know that they do it through the State level in many instances, but I don't have the experience myself. I wonder if we have ever seen that in our local communities.

Mrs. KONRAD. The one thing that we are hoping that we can get NSF funding to do is networking and involvement not only of college with precollege, but with business and industry.

What we are working toward now is a science equipment loan program. We are hoping that colleges, universities and businesses and industry will either lend or donate to us equipment that is perhaps obsolete for their uses but would be way ahead of what is already in the science laboratories in the schools.

If we could arrange a space to warehouse these and then we have our computer system so that we could arrange the programming based on the needs of the teachers, what kinds of equipment they need to teach a particular course, there might be a loan program which would make better use of what is already in the community or what could be given by the community to help the teachers bring new technological innovations into the classroom along with the instrumentation.

We are hoping that businesses and industry will provide, along with the equipment expertise, men who know how to use this equipment and would be willing on a pro bono basis to go into the schools and work either with the teacher during the teacher's free period or come into the classroom and help to integrate the use of new technology into the curriculum, as well as serving as a role model for science students, which is also important.

We haven't talked much about that today. We haven't addressed the role of women in science. We haven't addressed the role of men at the elementary level. This is something that we really should look at. The attitudes that are involved in these kinds of things, the role of minorities in science, all of these issues have not been touched on yet. I hope they will be touched on later in the afternoon. Obviously you can't do all of this at one session.

The science teachers feel these needs. That is how the Pittsburgh Regional Center for Science Teachers came into being. It was as a result of their needs. There are ways, and we know it is going to take time and money, but there are ways of utilizing their time and money allocated for health and science education so that it is more efficiently used.

If there are regional or even State levels of doing this, working with the media with production or updating of television, cassette

tapes that could be checked out to help a teacher learn to use a certain piece of equipment or to learn to teach a certain unit, this is no panacea.

None of these things is going to be the total answer, but it is a more efficient way of doing it. We are lacking funding as well, and we are just pulling ourselves along, but you can do a lot with a little if you organize and if you are efficient in the way you do it and if you can involve the community.

If you can involve business and industry and colleges and universities and parents—there are many well-trained parents who are either not working or not teaching and are wonderful resource people to come in to help even with content, if not in other ways, but it is just a matter of finding some way to organize all of this and put it together. I think that is where some kind of backing would be very helpful.

Mr. WALGREN. Do parents come into our schools here in Allegheny County?

Mr. MURPHY. We are very fortunate at our school. We have a well-organized—they have a title, but I can't say what it is—people who come in almost daily and run our copying machines and do many of those kinds of clerical tasks for us, and they really provide a great service.

We have had some interest in people who would help grade tests, but that is the kind of thing that most teachers that I work with are not too interested in having other people do those kinds of things that directly represent their contact with students, but some of these things are very helpful to us. We are very lucky to have them.

Mr. WALGREN. What about the Governor's suggestion that we increase the requirements, just the pure requirements for graduating from high schools to more time spent. I guess that is what it comes down to, in math and science?

Dr. DEBLASIO. I don't think that is too good of an idea. If you are not doing well in something, more is not the answer.

Mr. WALGREN. And we are not doing that well.

Dr. DEBLASIO. It doesn't seem to be progressing too well, no. Maybe we should consider a change in the basic formula. Traditionally throughout the years you have approximately 30 student groups with one adult who is the teacher. I would like to see that basic idea change. If you have to have 30 students, why not have 2 adults in the room, 2 teachers or a teacher and aide or do something a little bit different?

At our school we have a very different approach toward these things. The teachers can select their own instructional sequence. For instance, in my classes I had large groups. I meet with 65 students for one class and then in another class I might meet with them 25 at a time. The other time there might be 12.

I find that pattern to be very satisfactory because it releases the students and me from classtime and they can come and see me at other times. I can help students that don't really belong to me.

That basic formula could really be changed because in the long run, years from now, students will be coming to school maybe two days a week and will be doing work with video discs and computers in their own home, and perhaps at that time the schools will func-

tion as a social institution. That will be one of the main reasons that they come there. We are still a good ways away from that.

Mr. WALGREN. Is anybody using interactive computer and I guess screen television in their present education?

Dr. DEBLASIO. We started that in 1967. We have been doing it since then, so we have had a real good head start. We had a minicomputer that students used, and we had approximately 20 microcomputers at the high school level, maybe 6 or 8 or so at the middle school.

Mr. WALGREN. And you feel they are effective and that is a very constructive way to go?

Dr. DEBLASIO. Yes, sir; anything that gives you a different approach is an improvement, but you can't look to computers to alleviate the duties of the teacher. It is something else that we have to do.

When printed materials first came into education, I imagine the teacher said, "Well, this is great. I don't have to give lectures anymore. The students can read this on their own."

Well, as we all know, that wasn't the case. The teachers just had other things and more of those things to do, and in my involvement with computers over 15 or 20 years, I find that that is the same thing. It is just more things to do. You can't just turn that computer on and have it do a task. You either have to program it yourself or select programmed material. So, that is more for the teacher to do.

We are having a difficult time now in getting teachers to do that. Some equipment, I imagine, is sitting around being unused, not in my school, but I imagine there are places where that does happen.

Mr. BATEMAN. Mr. Chairman, if I might have your indulgence, in view of the fact that airlines don't fly when and where I want them to, I may have to leave earlier than I want. But I did want an opportunity to ask Dr. Caretto, after your students have been at your Governor's school and they go back at the end of the summer, do they then, I hope, tell their friends where they have been?

Dr. CARETTO. Yes, sir; at that point they do.

Mr. BATEMAN. That is good to hear.

Dr. CARETTO. But you do get different kinds of reactions. There have been cases where students have written to me and they said that the experience for the 5 weeks was so upbeat, they were so excited, they find that they are now back in high school and it is a tremendous letdown, it is tremendously boring, and that the worst possible situation is that I can understand why my friends are tired of hearing me talk about the Pennsylvania Governor's School, but my teachers don't seem to care, either. Again, that is an unfortunate situation.

One of the things they do try to do is indicate how good the experience was and in some instances some of these students have made presentations at school boards in their districts, talking about how they can try to improve some things.

Could I make a response to Congressman Walgren? You mentioned earlier about the involvement with the NSF. I personally am not involved. Carnegie-Mellon has been trying lately—and I believe they have this nearly ready to prepare a proposal to submit to the NSF—on the running of a teacher in-service program, which

perhaps could be tied together with the Governor's school so that teachers could come during the summer and see the Governor's school and simultaneously become literate at computers or a few other things that we could offer.

But frequently the teacher needs the summertime to make ends meet and look for other jobs. Therefore funding is necessary to run all this. So, that is why CMU is considering a proposal to the National Science Foundation.

Mr. BATEMAN. Mr. Chairman, before I have to go, I would like to just highlight an observation already made by you and by Dr. DeBlasio and Mr. Murphy.

With reference to the strides being made by other nations, and most particulary the Soviet Union, and perhaps to give some emphasis to how grave I think the problem is, I think in that context we should be reminded that in a number of areas of capability militarily it is unfortunately a fact that in something as sophisticated as nuclear submarines, the largest, the fastest, the deepest diving nuclear submarines are Russian, five different classes of them. We have two.

The most advanced and sophisticated deployed missile systems in the world are not American, but Soviet, and yet we take great comfort—I think a false comfort—in the notion that our technological capability as a nation nonetheless leaves us less at risk as these facts would seem to suggest. And hopefully that is true, but when you hear and focus on those statistics about the strides they are making as a society to increase their technological base and competence as a people, how long can we be assured of our security unless we, instead of declining in our technological capability as a society, as a nation, expand upon it?

It is an enormous challenge for all of the people of America, and certainly the challenge will not be successfully met except through our educational system.

I wish that I had the opportunity to be here and to hear the remaining panels. I am sure that they will be almost as good as the two that I have heard, and I am very sorry to have to leave without having heard them all.

Mr. WALGREN. Well, we understand, and we appreciate your coming for this period of time and know that you have a district to go to that is going to take you a 3-hour drive after an airplane flight. We all have commitments, and we appreciate your coming to Pittsburgh and look forward to working with you on what we can develop from here.

Mr. BATEMAN. Thank you very much.

Mr. WALGREN. One of the things that troubles me is when you look at the National Science Foundation budget, you do see supposedly programs that they are involved in, summer programs, summer excellence programs where they do try to give some recharging of the batteries to people who deserve the recognition and try to build in some reward for them.

And yet, it doesn't seem to be present when you look on the local levels. It makes you wonder about the breadth of those programs. It may be that some of them are being delivered under different auspices. I, for one, want to look at that and see how deeply that stuff is getting down to the local levels.

The same thing is true of the National Fire Academy, which is another responsibility of this committee. There is an excellent Federal fire program that you ask local fire people whether they know anything about it or have had any contact with it. When one of them from our part of the country goes down to the National Academy, they come back with their eyes wide open and say, "Gee, I never knew that was there."

And I get the same kind of feeling, a kind of different impression from what NSF looks like they are doing from Washington versus what is perceived by the school district after school district on a local level.

I wanted to ask quickly whether there is much pickup in homework these days or whether an adult has to be there to focus the attention? I am sure the parents are there, but are we turning away from homework? Is there a promise down the road of assigning more homework or is that just a wishful thought that gee, if we had the spine to pull ourselves up by the bootstraps, we would be up by the bootstraps at that point? Could I ask Dr. DeBlasio that?

Dr. DEBLASIO. That is a very difficult thing to respond to. I have been working at it for a good many years, and it is really difficult.

Mr. WALGREN. Some do and some don't. Is that right? Some students will and some students won't?

Dr. DEBLASIO. At the beginning of the year the student starts off doing it. It seems like they do. We work very hard trying to get them to do it and to improve it. I am to a point now where I spend part of class time at least to get them started on it so I can see while they are under my supervision that they are doing some of it. But it just never seems to be done to my satisfaction.

Mr. WALGREN. Have we tried to do some of the non-grade-judged programs with the students that might not be doing the homework? I understand if we bring in the Governor's School, the ones who really are motivated internally, you are going to have a good experience there. But how about the same approach with kids that might be—who don't excel as much?

Mr. CARETTO. Well, I don't have direct experience there. I would really have to defer to these people, but it would seem to me that if one could establish—what I am suggesting is very difficult, but if one could establish a rated challenge for any particular distribution of students in the class so that the student feels a challenge at the particular level that he is at.

Because if you try to standardize it, you are going to invariably find yourself aiming to some level. You are either going to be too high or too low or in the middle, and mediocrity of some sort will develop.

Mr. WALGREN. In science, in particular, I know that we need grades to go by, but I am wondering, is there a way to carve off a certain portion of science to perhaps use this nongraded approach anyway that should have an involvement of its own with all ranges of students or are we left to just having grades and then those who do excel will be the ones who think they are doing better and we can work with them, but the others really don't come along at all?

Mrs. KONRAD. You may not ever get away from grades. That is difficult to do, although that is part of the problem because if it is

grade grabbing and this occurs at a lot of levels rather than real learning, we are in difficulty. We know that.

But you mentioned something earlier about the new mandated amount of science and math that needs to be taken, and more is not necessarily better, and I don't think you can mandate learning, but it is a fact that the way things stand now with the requirements the way they have been, a student can take a science at the ninth grade level and never take another science course until they get to college, and if more will mandate that they at least be exposed to something between ninth grade and college, I think that is a positive and constructive step.

Now, it is important in terms of what you want to expose them to. I can't expose every student to a high-powered advance level course in either math or science. There are some students who never, at that level, attain the ability to do abstract reasoning. We know that some people never do, but certainly at that level there are many students who are not capable of taking more and more advanced science courses, but in lieu of doing away with grades, perhaps you could have some pass-fail, but one thing that we are looking at at least is to devise courses for nonscience majors, which will allow them to have an exposure to science to continue with their problem-solving skill development and to educate them in a basic way to those science concepts, which they are going to need to be informed citizens, at least so that they can vote for the people whom they have some expectation of believing will help to do the right things on a national level so that we can at least survive in this world. And I think that in looking at it at that level perhaps you can devise different kinds of courses.

Mr. WALGREN. Is there an inherent conflict between doing the most by some versus minimizing the failure. Can you see it in your students where you just see them pulling apart and you, I am sure, have to go to the ones that are doing something reasonable and——

Mr. MURPHY. I think that is probably the one thing that we notice the most. As the students get older, their divergence in interests and ability seems to grow. We offer in a 4-year high school 21 or 22 courses in mathematics. That is a lot. We presently have about 15 of those courses being taught. Not all of them are filled every year. I don't know if we, in a school of our size, could offer anymore courses or not.

I am sure that I agree with Dr. DeBlasio. I am for having more requirements of courses, let's say in mathematics. My attitude is you can't teach them if they are not there. If you get them in the classroom, we might be able to do something with them, but I am, at the same time, very concerned about the things that he mentions concerning how they will behave and what benefit they will have from it when they are there.

I don't know that they need to be placed in classrooms for entire years, or perhaps semesters would be long enough in some cases, but I think almost anything would be better than one credit in mathematics, which I believe is the present State requirement, and three credits that they are proposing seem fine to me. I wouldn't mind seeing four, and I am not looking for more work. At this time, I am not looking for a job as far as I know. Maybe after today.

You mentioned about students and their time. Let me mention this. I have two students who are currently applying for the Governor's in your recommendation, and they are good students, and they are nice students, and I made a big deal out of this.

We finally got to the place where I asked the girl if she could list her strengths and weaknesses for me as she saw them and then what were her extracurricular activities. These are questions on the questionnaire. This one student, a good student—and I wonder when she does get her homework done, I really do, she is current most of the time—she is in cross country, track and field, she is in a racquet ball club and she plays in some organized form of racquet ball. She is a member of the board for a teen center recently opened in our school district. She is in 4-H and works with horses. She has a job in a veterinary animal hospital. She has a route for the Pittsburgh Press after school. She is in a world affairs council in school. She is interested in that. She is in church activities. She is taking an after-school course for SAT preparation, and she is also babysitting. She is in her third year of Latin. She is in accelerated math courses, and she takes an advanced competition course.

Now, she is a very dedicated student. She said since she didn't have time to fit physics into her schedule, she is trying to learn it on her own so she got a book out of the library and she is trying to plow through that. She is just one. We can go down the list and find a girl that it was my fortune to recommend for a scholarship. It reads the same, and she works 20 hours a week besides.

I don't know today where the students are going to get the time to do the things that they are supposed to do for school. Even the good ones I don't know how they keep up, I really don't, because when I started to teach it was not this way. If I had two kids today who fell asleep in class from working after school meeting kids in the bowling alley that was a lot. Today a vast number of them have extra jobs and they are very, very busy. I agree school is a social setting today.

Mr. WALGREN. Let me ask Maryanne Bach, who is counsel of the minority, for one closing thought, and then we probably should go to the next panel.

Ms. BACH. I wanted to ask the panel about the guidance counselors in the high schools. Do all high schools have guidance counselors? What are the backgrounds of these guidance counselors? How do they interact with the students? Are they interacting with all ranges of students, not just the exceptional students?

Mr. MURPHY. In our guidance department I think we have two full-time and one part-time guidance counselor this year, and that is probably based on the ratio of students that we have to teachers. I don't know how those guidelines are structured.

One of our counselors teaches two math classes a day, and he was a former math teacher. Another counselor in our building I believe has a background in social studies, and a third I think has a background in foreign languages.

The guidance department is apart from the rest of us in our school. Their duties do not correspond normally to the duties of most teachers, and I can remember many years ago we had a meeting with the counselors in discussing their positions, said they were

fortunate that they did not have to participate in the disciplining of students or in the administrative details with students.

Now, I don't think that is always true, but they were saying that that was good that they didn't have to do that because those things tend to interfere with good relations with students, which is what is essential for guiding.

It is also what is essential for teaching. And when the teacher has to be the main person for discipline, I think we lose something in that as well.

Our counselors are good people. They work just as long as we do every day. They work long hours. They seem to visit with every student. I think that in preparing the student's schedule they have to meet every one of them. I don't believe we do group counseling like I have heard of in some schools.

Ms. BACH. Can anyone comment on the career counseling that is going on in the high schools?

Dr. DEBLASIO. I believe we have a very good program on that in St. Clair. We have a computer hookup to help students determine some leads in careers and college selection. The guidance counselors have about 300 students each that they counsel. They work very hard to get them into schools that they want, and they have a multitude of things they do in terms of actually counseling students who have difficulty with narcotics or alcohol and that sort of thing.

So, it is a very difficult job. And of course, every time something comes up, the school seems to acquire responsibility. If a student would attempt to commit suicide, for instance, there would be a flood of calls to the school saying to the school officials, "Well, just what are you doing to prevent students from taking this sort of an action?" So, guidance counselors as an area of influence is spiraling just like the rest of it.

Mrs. KONRAD. I am not evading a question, but I teach in a private school which is college preparatory, and our formal guidance or counseling is for college selection.

Personal guidance counseling is distributed equally. The duties are hopefully distributed equally among the teachers. The students are allowed to choose their own advisor, and each teacher is responsible for x number of students. They meet daily on a very minimal basis just to determine whether there are, indeed, problems that day that need to be solved. Long-term counseling and advising is carried on depending on the group of students that the teacher has as advisees and the time schedule that they have.

We try to arrange for career inspiration or counseling. They are either field trips or bringing speakers into the classrooms so that students have a chance to look-see at the various occupations that will be available to them. But it is not on any formal basis, and we will find that some teachers are more actively involved in that than others.

Mr. WALGREN. Well, thank you very much. We certainly appreciate the conversation we have had, and there are some points in there that we might be able to pursue. I appreciate your participation in the continuing education of the Congress in that sense. Thank you very much.

Mr. WALGREN. The next panel—and I apologize for running late, and I hope we haven't created conflicts, but we do have a panel of school administrators and school board members, Dr. Allen Blacka of the Mount Lebanon School District; Dr. Paul LeMahieu, acting director and senior research associate, division of testing and evaluation, the board of education, city of Pittsburgh; and Shirley Joyner, member of the Penn Hills School Board; and Reverend Lang, superintendent of schools for the diocese of Pittsburgh.

We appreciate your willingness to come and talk with us and join in these discussions. Let me just ask you to go ahead and give us your views and reactions and your guidance and then we can have at least a short discussion afterward.

Dr. Blacka?

STATEMENTS OF DR. ALLEN W. BLACKA, SUPERINTENDENT, MOUNT LEBANON SCHOOL DISTRICT; DR. PAUL LeMAHIEU, ACTING DIRECTOR AND SENIOR RESEARCH ASSOCIATE, DIVISION OF TESTING AND EVALUATION, CITY OF PITTSBURGH; SHIRLEY JOYNER, MEMBER, PENN HILLS SCHOOL BOARD; AND REV. HUGH J. LANG, SUPERINTENDENT OF SCHOOLS, DIOCESE OF PITTSBURGH

Dr. BLACKA. Thank you.

As superintendent of the Mount Lebanon School District, it is a pleasure for me to be invited here today. I would like to make some remarks about the nature of the science and math offerings in the Mount Lebanon School District.

We have a math and science program that exceeds the State mandates as they exist at the current time. In selecting course offerings, our students follow the theme to be challenged. We are fortunate in our high school that our principal is probably foremost a science educator, and he works with the students, thinking in terms of courses that challenge and courses that are more demanding of their time and effort.

As you read through the material that I presented to you, you will find that the courses vary all the way from those that students can only get into by teacher recommendation, courses that offer reinforcement and advancement to the students who wish to make growth in their math and science programs onto those courses that if they wish can participate in college level work and earn college level credit in our school.

These courses will give them college credit at a reduced cost. The advanced placement courses are there. In effect, when they enter our school, they can skip the particular course and receive college credit.

If you look into the science courses, you will find that there were laboratory type experiences in those courses. Youngsters, if they go into our laboratory settings in the computer science technology, are told that they have to spend hours beyond the school day working in the computer room.

In the matter of science, probably our top course is science research I want to point out that that course came about in our school district as a result of some grant money that enabled the teacher who is now working in that instructional area to begin that

type work and prepare those youngsters for the research experience.

In the matter of what it is that I see that the Congress can do, I have 10 thoughts on that.

One is assist us in our quest for qualified teaching staff. We are fortunate that the teachers that we do have have been with us through long years of experience, but the time is coming when they will need to be replaced. The supply out there is not adequate in terms of quantity.

We believe that you can do that through renewing the efforts of the National Science Foundation, where teachers are given student grants. We believe that you have to start back at the high school level and give support to science experiences such as the Pennsylvania Junior Academy of Science Fair, where youngsters gain an excitement about being involved in science.

Something has to be done to increase teachers' salaries so that teachers are attracted to this field. They compare unfavorably right now with those salaries being paid in business and industry.

In the second category of suggestions, I think that we should turn our attention to developing a strong student evaluation system, but one where the faculty of the school is involved in developing it. The goals and objectives locally developed should be tested and the aspects of those incorporated in the testing program.

A third category, a way in which Congress can help us is to assist our efforts in obtaining textbooks and supplies which are not diluted in content and overinflated in price. We find in the last 10 to 15 years that the content of textbooks has been watered down. We also feel that the materials that are so necessary to conduct laboratory experiences, equipment are overpriced.

If you could instigate an investigative study of these practices, perhaps some things can be learned. Maybe the schools are not making the demands that they should upon the suppliers.

A fourth effort we need help with is in the area of developing laboratory activities. These are the areas—and you heard this before this morning—where youngsters learn the practices that they need to follow in the world of science and mathematics.

The fifth area where we need help is in the area of developing departmental leadership. Quite often, as in the case of our high school principal, a science teacher has become an administrator, as in my case, from mathematics to teacher to superintendent of schools. We need to be developing the leadership with the departments and finding ways to attract that leadership into staying within the departments.

A sixth area is aid in writing computer software to accompany all the hardware that is available. The computer needs to be used and can be used as an educational tool. Grants could be provided for the software writing. We believe that it should be written at the local level by the educators, who know what it is that they are planning to accomplish.

A seventh area is that we need assistance in establishing a closer relationship with business and industry. I think that forums should be held, and we do see some of this occurring in the city, where business and industry meet with educators. Points of view are exchanged and common problems solved.

An eighth area where we believe we can have some help and should have some help, if we are going to talk about science and math, the subjects, they need to be related to the problems of society. We can't let issues like the development of military weapons and so on become the focal point. These youngsters are going to have to take their place here in society. There are problems such as the quality of life and pollution. So, the content has to be related.

A ninth area, one that we tend to look around and avoid, is that of a student competition and awards system. Over the years we have neglected to continue recognizing the students who do well. It has been a way of schools to tend to work with all of the youngsters, but those who do well make relative growth in their academic standing, not just those who obtain an A or a 100-percent rating. These award systems develop bonds between students and faculty members. It is an inspiration to the youngsters.

The last area, probably the most important, is that we need help in gaining parent and community support. No school system can teach, lead, reward or test the student body unless the parents are willing to pull together with us in making this effort. We thought about this. The one suggestion we have is that we keep the legislative and political spotlight on education. Make it among your top priorities.

These ten suggestions I hope are of some help to you as you think about your work. If there is any other way that the Mt. Lebanon School District can be of a help to you, please feel free to call on it. Thank you.

[The prepared statement of Dr. Blacka follows:]

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Testimony Presented to Doug Walgren, Chairman House Subcommittee

on Science, Research and Technology

Committee on Science and Technology

U. S. House of Representatives

February 10, 1984 - 9:30 A.M.

David L. Lawrence Convention Center

Pittsburgh, Pennsylvania

by

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Public School Mathematics and Science Education

Ladies and Gentlemen of the Subcommittee on Science, Research and Technology -

It is a pleasure for me as Superintendent of the Mt. Lebanon School District to be invited to speak on the subject of mathematics and science education. You are to be commended for your efforts.

My remarks are divided into two parts -

(I) The Nature and Quality of Mathematics and Science Eduation in the Mt. Lebanon School District and

(II) Suggestions for the Improvement of Mathematics and Science Education in the Public Schools.

Part (I) - The Nature and Quality of Mathematics and Science Education in the Mt. Lebanon School District

The nature and quality of our curriculum offerings in high school mathematics, technology and science are evident by the content and scope of our course descriptions. The school district's requirements for graduation are greater than the present State mandates. The theme of our high school program "Choose to be Challenged" is a reflection of our work to influence students to select courses deemed to be more challenging and demanding of their time and effort. The following paragraphs will give you insight into the nature and quality of our program offerings.

MATHEMATICS EDUCATION

Modified - INTRODUCTION TO HIGH SCHOOL MATHEMATICS - This course provides an introduction to high school mathematics by concentrating on four main areas:

1. Review of basic computational skills
2. Introduction to geometry
3. Overview of consumer mathematics
4. Introduction to algebra

This course provides the opportunity for students to receive additional review of computational skills throughout the year.

Modified - GENERAL MATHEMATICS - General Mathematics emphasizes modern mathematical concepts, techniques, and skills needed for an understanding of the practical and social phases of mathematics. Course topics (divided into ten Resource Units) are selected from arithmetic, algebra and geometry. For the best interest of the general student, this course is set up to follow such learning models as individualized instruction, math laboratory experiments, and small group sessions. An attempt is made to correct each individual's arithmetic weaknesses.

Modified - PERSONAL FINANCE - As future active participants in the American marketplace, students should acquire the ability to understand financial questions. This ability will depend upon effective application of fundamental arithmetic operations. Topics covered will include banking, taxes, insurance, budgeting, credit, unit pricing and many other everyday problems.

Modified - ALGEBRA I - The emphasis in this course is on developing algebraic skills rather than algebraic concepts. The course begins with a review of pre-algebra topics including work with signed numbers, graphing on the number line, order of operations, and absolute value. Later topics covered include solving equations and inequalities, translating from words into mathematical symbols, elementary word problems, laws of exponents, working with polynomials, factoring, quadratic equations, algebraic fractions, and graphing lines in a plane.

ALGEBRA I - Algebra I emphasizes the overall structure of the real number system. The students will learn to apply the manipulative techniques as a reflection of this structure. The concepts of variables, number properties, positive and negative numbers, relationships between numbers are studied and then applied to the solution of equations and inequalities. Verbal problems are an important part of this course. Emphasis is placed on the development of deductive reasoning, changing words into symbols and on the application to verbal problems. The students should have a sound background in the basic concepts of arithmetic including operations with whole numbers, common fractions and decimals before selecting this course.

Other topics include factoring algebraic fractions, graphing on the coordinate plane, solutions of system of linear equations and simple quadratic equations.

Honors - ALGEBRA I - Honors Algebra I is a fast-paced rigorous treatment of first year Algebra. Time is one of the criteria measured. Comprehensive unit tests cover large units of work for this level.

Students should be able to recognize mathematical patterns and be able to utilize them when they appear in other circumstances. They should also perceive the role of deductive reasoning in algebra. Resource units include topics such as applications of equations, inequalities, factoring, fractions, linear systems and quadratic equations.

Modified - GEOMETRY - Modified Geometry represents adjustments made in the regular offering in order to accomodate certain students whom we anticipate might have trouble. An attempts is made to emphasize small groups and individual instruction. Admission is by teacher recommendation only. Students admitted to this course should have successfully completed Modified Algebra I.

GEOMETRY - Geometry is based on undefined terms (point, line, and plane), defined terms, and postulates, all of which are used to prove theorems and solve problems deductively. Understanding of the relationships of plane figures is achieved through the study of:

1. lines and segments: equal, congruent, perpendicular and parallel.
2. angles: equal, congruent, supplementary and right.
3. polygons: equal, congruent, similar and special properties of certain polygons.
4. circles: angles, arcs, segments, properties of circles and constructions.
5. inequalities: segments and angles.

Honors - GEOMETRY - Honors Geometry is based on undefined terms (point, line, and plane), defined terms, and postulates all of which are used to prove theorems and solve problems logically by deductive reasoning. The understanding of the relationships of plane figures is achieved through the study of:

1. lines and segments: equal, congruent, perpendicular and parallel.
2. angles: equal, congruent, supplementary, complementary and right.
3. polygons: equal, congruent, similar and special properties of certain polygons.
4. circles: angles, area, segments, properties of circles and construction.
5. inequalities: segments and angles.
6. coordinate geometry: slopes, parallel and perpendicular lines, graphs and equations.

Solids and their volumes are included where possible to supplement and increase student's ability to solve geometric problems.

Honors - ADVANCED GEOMETRY - Honors Advanced Geometry is the first of the sequence of courses comprising the Advanced Placement program in the senior high school. It is based on undefined terms (points, line, and plane), defined terms, and postulates all of which are used to prove theorems and solve problems logically by deductive reasoning. The understanding of the relationships of geometric figures is achieved through the study of:

1. lines and segments: equal, congruent, perpendicular and parallel.
2. angles: equal, congruent, supplementary, complementary and right.
3. polygons: equal, congruent, similar and special properties of certian polygons.
4. circles: angles, area, segments, properties of circles and construction.
5. inequalities: segments and angles.
6. coordinate geometry: slopes, parallel and perpendicular lines, graphs and equations.
7. lines and planes in space: perpendicular and parallel.

Solids and their volumes are included where possible to supplement and increase student's ability to solve problems.

Modified - ALGEBRA II - This second year algebra class is designed to emphasize review, reinforcement, and improvement of the basic algebraic skills. First year algebra topics are thoroughly restated with emphasis on understanding concepts and mastering manipulative skills through flexible pacing and opportunities for increased individualization.

This course is not generally considered to be college-preparatory but may satisfy entrance requirements for some 2 or 4 year programs. New units include linear systems, exponents, radicals, complex numbers, quadratic relations and functions.

The majority of the students in the class should be juniors or seniors who have completed first year algebra and geometry by doing satisfactory work in modified classes or have experienced difficulty in regular classes.

The student who is most successful at this level is one who wants to learn, is willing to work hard, but needs individual attention and varying techniques afforded by the smaller classes to demonstrate growth of mathematical skills.

ALGEBRA II - The purpose of this traditional second-year algebra course is to first build on the foundations learned in first-year algebra, to expand the understood concepts by generalizing, and to review first-year algebraic topics by examining more difficult problems and new types of problems in order to ensure that the student has strengthened his/her grasp of the fundamental algebraic manipulative skills. Problem-solving skills, clear and concise expression both oral and written, and logical thinking are emphasized throughout the course. This course is designed to be a college-preparatory course which satisfies college entrance requirements in second-year algebra. New units covered include radicals and complex numbers, quadratic sentences, quadratic relations and functions, conic sections and analytic geometry.

Honors - ALGEBRA - This challenging fast-paced course emphasizes the improvement of strong manipulative skills, concise expression, logical thinking, problems solving and analysis. Algebra I concepts are reviewed and strengthened through intense practice and generalization techniques. New topics are developed both mechanically and intuitively.

This course is designed to be a college-preparatory course which satisfies college entrance requirements in second year algebra while also preparing the students for the possibility of doing extensive college level work in mathematics or related areas. New units covered include three variable systems, radicals and conic sections and analytical geometry, exponential and logarithic equations, sequences, series and the binanial theorem.

Honors - ADVANCED ALGEBRA II - Honors Advanced Algebra II is the second of the sequence of courses comprising the Advanced Placement program in the senior high school. The content of the course is second-year algebra. Topics include linear and quadratic equations and relations, logarithms, the set of complex numbers and operations with radicals. Applications of first year concepts to complex problems is included. Areas of advanced study include partial fractions, an introduction to probability and statistics and relations in a three-space reference system.

Modified - ALGEBRA III/TRIG - This course is designed for those students who need to strengthen their algebraic skills. It is a full year course, though credit is granted for completion of first semester work.

Proficiency with algebra will be developed with a review of these basic ideas: solving linear equations, inequalities and systems; and solving quadratic equations and inequalities.

In order to expand the students' understanding of algebra these new topics: linear analytic geometry, conic sections, quadratic systems, logarithms (using hand held calculators), polynomial functions and elementary trigonometry will be introduced. Optional topics include an overview of arithmetic sequences and series, and the basic concepts of statistics and probability.

COLLEGE ALGEBRA/TRIGONOMETRY - College Algebra/Trigonometry introduces and develops many of the topics found in introductory college mathematics courses. This course is designed to review previously learned concepts, extend those ideas to develop concepts of higher mathematics, and integrate geometric, algebraic, and trigonometric concepts. Because this course places less emphasis on proofs and abstract reasoning than most precalculus courses, many students upon completing this course will require at least a semester of precalculus at the high school or college level before enrolling in calculus.

Trigonometry is introduced early in the course for the benefit of students taking standardized tests, but trigonometric concepts are reinforced throughout the course where applicable.

As preparation for those students who will eventually continue with calculus, the graphing of functions is emphasized throughout the course. Other topics include a review of linear equations and inequalities, quadratic equations and inequalities, coordinate geometry, conics and functions. New topics include circular functions, triangle trigonometry, exponential and logarithmic functions, trig formulas, complex numbers and polar coordinates, polynomial functions, series and sequences, and probability and the binomial theorem. Many of these topics will be integrated in units studying techniques of graphing functions and techniques of equation solving.

Students electing this course should have access to a calculator with trigometric and logarithmic capabilities.

Honors - PRECALCULUS - This full year course is designed to prepare students for Calculus, whether it be their first math course in college or their terminal course here at the high school. It is urged that students have completed course Honors Algebra II. The course begins with a thorough development of functions. This includes notation, operations, properties, equations, and analysis of graphs.

A complete development of trigonometry is covered in Precalculus. It starts with wrapping function and work with the circular functions leads to the remaining units of trigonometry which include solving trigonometric equations, proving identities, analyzing graphs of direct and inverse functions, and working with complex numbers. A unit on polar coordinates which includes graphing follows.

A major portion of the course is devoted to special types of functions. Work is done with polynomial functions, rational functions, exponential functions, and logarithmic functions.

The conic sections are developed thoroughly including translation of axes. A study of mathematical induction as a method of proof is followed by the binomial theorem. This leads to an examination of the patterns in mathematical sequences and series, and to the concept of limits.

Honors - ADVANCED PRECALCULUS - Honors Advanced Precalculus is the third of the sequence of courses comprising the Advanced Placement Program in the Senior High School.

Honors Advanced Precalculus is a strong supporting course for the calculus in twelfth grade. It continues and extends the algebra of the real number system; it includes such topics as theory of equations, and parametric representation of curves and surfaces. Also studied are the complex number system with its field properties and the conics. Mathematical induction is related to the proof of the binomial theorem. The derivation function is developed in an intuitive manner and simple applications are considered. Properties of functions are studied in detail. Also included are analytic geometry, trigonometry, and vectors. The emphasis in trigonometry is on the circular functions, radian measure, inverse functions, graphing and complex number representation. Students electing this course should have access to a calculator with trigonometric and logarithmic capabilities.

Honors - CALCULUS - Calculus is a one-year college level course which builds the general theory and techniques of calculus upon a review of the elementary functions and upon a review of algebraic topics as needed. Topics include differentiation of polynomial functions; differentiation of trigonometric exponential, and logarithmic functions; area, Mean Value Theorem, and the definite integral; integral techniques; applications of the derivative and the integral. Students successfully completing this course may elect to receive 4 credits from the University of Pittsburgh for a fee. Students who complete this course before their senior year may wish to participate in college-level calculus at a local university. Reduction in tuition is often available for students who are still enrolled in high school.

Advanced Placement - (BC) CALCULUS - Advanced Placement (BC) Calculus is the last of the sequence of courses comprising the Advanced Placement Program in the Senior High School.

Advanced Placement (BC) Calculus is a one-year, college level course in calculus and related analytic geometry. Its content is that of the BC Calculus course prescribed by the CEEB Committee on Advanced Placement Mathematics. The course involves an extensive and in-depth study of differential and integral calculus of functions of the variable, sequences and series and introductory differential equations.

Emphasis is placed on theory and formal proof.

It is hoped the the student will sit for the Advanced Placement (BC) Calculus Examination. Successful performance on this examination frequently earns a year's credit and/or placement at the college level. Students who complete this course before their senior year may wish to participate in college-level calculus at a local university. Reduction in tuition is often available for students who are still enrolled in high school.

COMPUTER SCIENCE EDUCATION

COMPUTER SCIENCE TECHNOLOGY - The course is divided into two parts. The first is concerned with the extension of the human being's sensory powers. This includes how the computer is used to take data in experiments, make graphs and data tables, in modeling, in simulations, and in problem solving. The student will learn how to interface the computer to take temperatures, times, and other applications. This part also deals with some social problems of technology.

The second part addresses itself to the extension of a human being's mental powers and develops the technical basis for automation. This includes what a computer is, what a computer can do, and how it works. Also simple computer logic and machine language will be investigated.

Students will learn to write programs in BASIC and run them, however programming skills are not a major objective.

The Computer Science course is designed for the average and above average student who would like to learn how computers and technology are applied to "real life" situations.

COMPUTER PROGRAMMING I - BASIC - This course is designed to give the student a first hand knowledge of the capabilities and limitations of computers and to develop computer programming skills in the BASIC language. There is an emphasis on simple, top down, structured, well documented programs.

Specific topics include flowcharting, elementary programs, conditional executions, loops, formatting output and subscripted variables. These topics are covered both in classroom lectures and in computer lab sessions.

Students taking this course should be enrolled in or have completed second year algebra. The completion of geometry is also recommended.

Students should be aware that they will be responsible for many lab type assignments that may require time in the computer room other than during the normal school day.

COMPUTER PROGRAMMING II - Adv. BASIC - This course is designed to increase knowledge of computer operations and to develop sophisticated programming skills in BASIC. As in Computer Programming I - BASIC, the emphasis is on the student's ability to write top down, structured, well documented programs.

Specific topics covered include sort procedures, two dimensional arrays, matrix arithmetic, string functions, data types, external data files, and graphing and graphics. Classroom time to cover these topics is divided between lectures and the computer lab.

Students taking this course should be aware that they will be responsible for many lab type assignments that may require time outside of the normal school day. Currently an arrangement between the high school and the University of Pittsburgh makes it possible for students to register and receive credit for the three credit course, CS - 4, Introduction to Programming in BASIC.

COMPUTER PROGRAMMING - Fortran IV - Computer Programming Fortran IV may be elected by any student who has taken or is now enrolled in Algebra II or higher math courses. Computer Programming - Fortran IV is a one semester course designed to develop in detail the programming language, Fortran IV. This language is the most common one used in mathematics and science.

The course will cover the features of computer hardware and software (programs). Fortran methods of input and output, Fortran statements, sub-programs and sub-routines are studied. Computer technology is used to solve algebraic, geometric, and related problems. Students program and operate various kinds of computers. The computers may be a disk operating system, or a cassette system. The output will be displayed on a terminal or the students may have a print out.

Advanced Placement - COMPUTER SCIENCE - This course is designed to provide the equivalent of one year of Computer Science at a good university. It follows the curriculum as prescribed by the CEEB. Because this curriculum is strongly mathematical it is required that the course be taken concurrently with or after completion of a precalculus course.

The course begins introducing structured programming methods and techniques by writing instructions for a primative robot with capabilities as described in Karel the Robot, one of the courses texts. It continues using the computer language, Pascal assignment statements, conditional execution, loops, functions, procedures, arrays and files will be covered as well as more advanced computer science topics including Data structures (linked lists, lists, stacks, quells and trees), sorts (selection, exchange, insertion, binary tree, mergesort, and quicksort), tuning machinges and automata, recursion, program correctness and verification, assembly language, and simulation. Some lab time is provided for students during the normal class day. However, students should plan on spending a minimum of two hours a week outside of class time in the computer lab.

This course prepares students for the CEEB exam in Computer Science.

SCIENCE EDUCATION

INTRODUCTION TO PHYSICAL SCIENCE - The Introduction to Physical Science (I.P.S.) course is considered to be an appropriate introductory/exploratory experience for the majority of ninth grade students. The course explores physical science concepts through the extensive use of laboratory experiments and demonstrations. The development of good laboratory skills is an objective of the course. A content background in the physical sciences is developed through classroom activities. The I.P.S. course develops the concepts through a developmental approach. Two examples of major concepts are properties of matter and the atomic theory.

Modified - LIFE SCIENCE - Modified Life Science is an activities oriented course where students complete prescribed learning experiences, including experimental procedures, individually at their own pace. Procedures are developed in such a way that conceptual learning of the following topics emerges: processing and organizing data, microscope techniques and study, plant structure and function, animal organs and systems, and human beings and their environment. Modified Life Science offers the student a sound, conceptual base that will enhance their understanding of a course in Biology. The students in Modified Life Science "learn by doing," working at their own pace.

BIOLOGY - Biology is an introductory laboratory science course. The course in Biology covers basic principles that govern all living things and also stresses the methods by which scientists investigate them. Themes developed during the course are: the structural and functional nature of life; genetic principles and applications; systematic study of micro-organisms, multicellular plants and animals; human physiology; and ecological relationships. Double periods are scheduled for laboratory activities. A focus on careers and an emphasis on breakthroughs in biology provide highlights in the course.

ECOLOGY - The Ecology course stresses the relationships that occur in natural systems as well as the interactions of man with his environment. Current environmental problems, such as pollution and energy, are reviewed. Considerable emphasis is placed upon the study of natural ecosystems and the technology of the human environment. Although Ecology is not a laboratory science, activities such as computer simulations are extensively used to model real problems. The opportunity for field work is also available. Science, society and technology issues are explored as students practice decision making. The students are made to realize that they have future roles as the planet earth's stewards.

Honors - TOPICS IN BIOLOGY - Plant Growth and Anatomy; Genetics - Plant Growth and Anatomy is a review of normal growth processes. Following this review, developmental plant anatomy from seed to mature plant is studied. The effects upon plant development by environmental factors such as light, temperature and moisture are investigated. Natural and synthetic plant growth substances are studied in detail with emphasis placed upon the changes resulting from their application.

Genetics is an investigation of the mechanisms of mitosis and meiosis. Various plants are used to demonstrate the principles of Mendelian genetics and various aspects of chromosome theory.

Patterns of heredity in sexual reproduction are investigated using microorganisms and population genetics. The effects of environments upon genetic expression and mutation are discussed and aspects of human genetics are investigated.

Honors - TOPICS IN BIOLOGY - Microbiology and Molecular Metabolism - Microbiology is primarily concerned with techniques used in the culture, observation and identification of microorganisms. Emphasis is placed on the study of procaryotic cells such as bacteria but attention is also given to eucaryotic algae and fungi. Activities include staining and observing cells, transferring and culturing, nutritional requirements, growth factors and enzymatic activities. The techniques of medical, industrial, agricultural and food/water sanitation microbiology are utilized.

Molecular metabolism includes investigations to determine the biochemistry of protein, nucleic acids, fats, polysaccharides and enzymes. The manner in which organisms use energy, such as muscle contraction and bioluminescence are also investigated. Chromatography and electrophoresis are used in the investigations.

Modified - BIOLOGY - Modified Biology assists the students in determining how they and their fellow students are becoming involved in the cycle where human activity changes the environment. The major areas of investigation and discussion are: major environmental and biosocial problems caused by pollution, interactions of organisms with the environment and the earth's major ecosystems, interactions within organisms in different environments and genetics - how the patterns of inheritance operate.

EARTH SCIENCE - Geology - Geology is a course in physical and historical geology. Topics covered include: minerals and rocks, topography and landforms, processes of weathering and erosion, fossils, diastrophism and volcanism.

EARTH SCIENCE - Oceanography and Meteorology - This part of the course deals with oceanography and meteorology. Topics covered include: oceanic exploration; the structure, composition and properties of the oceans; movements of water and energy transfers; circulation patterns; storms and fronts; air masses; weather predictions; and climate.

ASTRONOMY - The course in Astronomy provides students with the opportunity to study the oldest formal science. Using the planetarium and a multi-media approach, a focus is provided to allow students to experience the applications of basic sciences (physics, chemistry, and biology) in a setting that simulates observations of natural phenomena.

The observable universe is investigated, from inner space to the limits of the known universe. The study then moves the students from what is known to speculation about what may be. Descriptive aspects of the sky are stressed through liberal use of planetarium observations. Examples of topics presented are: the history of astronomy; astronomy vs astrology; constellations; the solar system; the moon; properties of light; motion and forces in space; stars and stellar properties; order in the universe; unusual and exceptional phenomena such as black holes, pulsars, white holes; and biological phenomena.

Advanced Placement - BIOLOGY - Advanced Placement Biology is a college level course for twelfth grade students. Living organisms are studied from the cellular, genetic, organismic, and ecological perspectives. The anatomy and physiology of monera, protists, fungi, plantae and animalia are studied in detail. In-depth analysis of current research areas such as recombinant DNA and gene splicing provides students with knowledge of major trends in biological research. Laboratory exercises provide hands-on

experiences with the basic tools of biological research which can then be applied to original research projects.

A primary purpose of the course is to prepare students for the Advanced Placement Examination. However, any college bound student, especially a student planning to major in the sciences would benefit from this course.

CHEMISTRY - This Chemistry course is intended for the average student who by the eleventh or twelfth grade has the mathematical skills and mental maturity to deal with the concepts and theories of chemistry. This course is intended for the student who plans a non-science career and it is an adequate preparation for the non-science oriented college student.

The course utilizes both classroom and laboratory approaches in a study of the following topics: the metric system, atomic structure, the periodic table and properties of the elements, chemical bonding, chemical formulas and equations, chemical reactions, reaction kinetics, stoichiometry, equilibrium, states of matter, acids - bases - salts.

Honors - CHEMISTRY - The Honors Chemistry course is designed to provide the science and/or technology oriented student with a rigorous approach in the study of chemistry. The Honors Chemistry course is significantly different from the regular chemistry course in scope, depth and pace. Student who intend to take the College Board Achievement Test should take this course.

Major topics studied in the course include structure, bonding, periodic law, energy and matter, stoichiometry, kinetics, equilibrium, acid-base theories, redox and electrochemistry and organic chemistry. The laboratory is used to acquaint students with real scientific experiences and to add a functional aspect to their understanding of principles.

Advanced Placement - CHEMISTRY - The Advanced Placement Chemestry course is taught at the college freshman level. The emphasis is on chemistry as an intellectual activity and on rigorous training in fundamentals needed for advanced college courses in chemistry or related fields. This emphasis on concepts and principles requires students to learn descriptive material from their laboratory work and also from outside reading.

The primary purpose for the course is to prepare students for the Advanced Placement Examination. However, any student planning to major in chemistry or engineering would benefit from the course.

PHYSICS - This course is based upon the Project Physics format designed for students who wish to broaden their physical science background as a preparation for college. This course is not recommended for students planning a career in engineering. Those students should take Honors Physics and Advanced Placement Physics.

This Physics course places emphasis upon student classroom activities, lab work and student projects. This course differs from Honors Physics in depth, it moves at a slower pace and has a significantly different order of topic presentation. Major areas covered are the concepts of force, momentum, heat, waves, light, electricity and magnetism, and terrestrial and celestial motions.

Honors - PHYSICS - This course is recommended for the student planning a career in science, technology or engineering. Honors Physics differs from regular Physics in that it goes into greater depth, moves at a faster pace and has a different order of topic presentation. This course includes the study of the following topics: motion and forces, heat and temperature effects, basic electrical principles, visible and invisible light, sound waves and atomic structure. The labaoratory provides students with the opportunity to investigate the principles of physics first hand.

Advanced Placement - PHYSICS - The Advanced Placement Physics course is taught at the freshman level of college work. Students taking this course have the opportunity to use concepts from the Advanced Placement Mathematics course.

The student in Advanced Placement Physics is required to exercise a greater degree of mathematical sophistication than students in Honor Physics. Also, the depth and detail of coverage of topics requires a more rigorous approach in teaching and learning.

Although this course prepares students for the Advanced Placement Examination, any student planning a career in science or engineering could benefit from this course.

SCIENCE RESEARCH - This course is designed for the student in grades 10, 11 or 12 who wants to participate in an independent research class. The course allows students to investigate problems requiring creative solutions. The problems can be in either the natural or physical sciences and require students to carry out controlled experiments and to draw valid conclusions based upon gathered data. The students present their findings in both written and oral forms. They are also expected to submit their research projects in science competitions, locally and perhaps regionally. Significant scholarship opportunities are frequently derived from research projects in this course.

In summary, we believe that the quality of our mathematics and science programs ranks with the top 2% of the nation's schools. This position has been acquired over a long period of time. Recently because of declining enrollments our energies have been directed toward consolidation of our curriculum offerings and the maintenance of a quality faculty.

The quality of our mathematics and science faculty is evident.

Department	Years of Service	Degree of Status	Average Annual Salary
Mathematics	19.2	Masters Degree +15 Graduate Credits	$27,700
Science	19.2	Masters Degree +30 Graduate Credits	$29,000

The quality of our student body is also evident. We have scored above the national average on mathematical SAT scores and have been consistent in our comparative achievements with similar school districts. We have had an enviable number of merit scholars. We are proud of their achievement. Approximately 85% of our students go on to higher education.

Part (II) - Suggestions for the Improvement of Mathematics and Science Education in the Public Schools

We want to continue our forward pace in mathematics and science education. We ask your help with the factors over which we, as one school district, have little or no control.

1. Assist us with our quest for a qualified teaching staff.

   It is our opinion that the quality of the teaching faculty is the primary factor in determining a quality school. We find that there are fewer teachers of mathematics and science available. Salary structures cause difficulty in attracting teachers with preparation and experience in mathematics and science.

   - Renew the efforts of the National Science Foundation thereby providing study grants to teachers of mathematics, technology and science which expand or renew their capabilities.
   - Give grants to school districts for use to encourage teachers to involve students in such competitions as the Pennsylvania Junior Academy of Science Fair.
   - Provide funds to raise teachers' salaries to levels competitive with business and industry.
   - Encourage, through funding, curriculum and subject area content development projects.
   - Lead in the effort to incorporate in our teacher certification process requirements for higher standards which are consistent and relevant.

2. Assist us in our determination to develop a strong student evaluation system encompassing the aspects of being faculty developed, being used to establish standards, and being an integral part in the effort to revise curriculum and teaching practices.

   - Call for and fund student evaluation programs for each school district which are developed by the teaching staff.

3. Assist us in our efforts to obtain textbooks and supplies which are not diluted in content and inflated in price.

   - Instigate an investigatory study of the practices in the school textbook and supply industry.

4. Assist us with the efforts to sustain a program rich in laboratory activities where such experiences have been reduced because they are considered too costly.

   - Provide direct aid to the school laboratory programs.
   - Seek ways to reduce the cost of laboratory equipment.

5. Assist with the identification and development of departmental leadership.

   - Fund special leadership and management programs in the areas of mathematics, technology, and science instructional leadership.
   - Fund leadership activities in such areas as conference attendance, membership maintenance, and study seminars.

6. Assist with the need for software development which would enable us to use the technological hardware as an educational tool.

   - Provide grants to those who will commit the time and resources necessary to prepare instructionally sound software.

7. Assist us with establishing a closer relationship with business and industry.

   - Hold forums where leaders from industry can meet with educators for the purpose of exchanging views.

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- Give grants to industries which would release mathematicians and scientists to work with teachers in classrooms.
- Create regional educational research councils to be funded by industry and formed as a partnership of industry and education.

8. Assist us with the development of courses relating the subject content to societal issues of pollution, quality of life, conservation and the impact of new technologies among other issues which bring respect to science and mathematics as bodies of knowledge which give improvement to our lives.

   - Provide for course development grants.

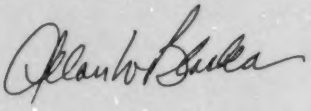
9. Assist us with the creation of a viable student competition and awards system which serves as a bond among faculty members, a career development opportunity for students, and an inspiration to individual teachers.

   - Give seed money grants to industries who will make such awards.
   - Develop a research project which studies the issue and makes a report on the most appropriate method, use, and type of student recognitions.

10. Last, but easily the most important. No school can teach, lead, reward, or test successfully without parent and community support. Assist us in obtaining this support from parents.

    - Keep the legislative and political spotlight on education.

I conclude my comments with my expression of appreciation for this opportunity to inform you of our desires. Please know that the Mt. Lebanon School District and I support you in your search for excellence in mathematics and science education. We are available if you find further ways in which we can help.



Mr. WALGREN. I appreciate that testimony very much, Dr. Blacka.

Let's continue on with the rest of the panel in the order that you were called, so I will turn to Dr. LeMahieu at that point.

Dr. LEMAHIEU. Let me start, first of all, by offering the regrets of Dr. Stan Herman, who was required to be at other legal proceedings and asked me to come and stand in his stead.

The testimony which we prepared for this committee is essentially a short status report on issues related to science education as they pertain to the Pittsburgh public schools. I am going to touch on just a few areas raised in that testimony. First of all, graduation requirements in the Pittsburgh public schools. Second, curricular approaches in science and technology, and last, and probably last because it is the most important in our view, teacher preparation, both preservice and inservice.

At present students in the Pittsburgh public schools are awarded differentiated diplomas, depending on the courses of study which they undertake. The minimum requirements are for two units of math and two units of science. The academic diploma requires an additional mathematics course, and it should probably be observed that in addition to that, through counseling and other efforts, students in the academic track tend to also elect an additional science course.

With the freshman class of 1985, all students will be required to take three units of each, both mathematics and science, for graduation. This is symbolic, I think, of our support for the social proposals that have been offered.

But we make the statement, also, that increased time has got to be coupled with quality time and that every effort has got to be made to increase the quality of the instruction which is offered in those courses, and for that reason we turn to the two other areas, both curriculum and teacher preparation.

Apropos of curriculum, let me say, in 1980 the Pittsburgh Board of Education identified increased student achievement as a top priority. The major programmatic effort which has been initiated to promote student achievement in the basic skills areas is the monitoring achievement in Pittsburgh program.

The MAP program seeks to integrate instruction and testing through the specification of instructional objectives which form the core of the curriculum. It seeks to integrate both instruction and testing through the specification of instructional objectives as part of the core of the curriculum. Student achievement on each of those objectives is then measured through frequent testing with instruments linked directly to the instruction. The tests are scored by computer and results returned to teachers within 10 days for their use in instructional planning.

At the present, the MAP program is fully operational in three academic areas: mathematics, grammar/composition and reading. In addition, we have underway a pilot program in the area of critical thinking.

The results of the MAP program as it enters its third year of operation have been fairly dramatic. Its resulted in an increase in student achievement in the basic areas subsumed by the program. However, the last year we have administered for the first time

standardized tests for students in the secondary level in elected mathematics and science courses. The results, I would have to report to the committee, were disappointing in the extreme. The results established two goals for science and mathematics throughout Pittsburgh. First, we intend to increase student achievement in these areas, and second, we have to increase the percentage of students scoring at or above the norm.

Currently we are involved in extending the MAP program into secondary schools and focusing on higher order thinking skills as well as subject areas in the math domain and all areas of science and technology.

Let me turn finally to teacher preparation both in-service and pre-service, and I would speak, first of all, to the elementary schools and second, of middle and secondary schools.

Elementary schools, because of the current patterns of certification requirements, usually have very little formal training in the teaching of science. Curiosity and creativity are stifled when students' questions cannot be answered. Even worse, incorrect information is often taught which must then be unlearned at some later point.

Tragically, and probably quite telling, several studies have shown that students rank science as a favorite subject at the beginning of the third grade and that preference, however, steadily declines until science is ranked as the least favorite subject of ninth grade students.

Science in the elementary schools has often been relegated to "back burner" status. The time allotted to science teaching is often usurped. At present, students receive two or three periods each week, and in some cases, I am sorry to have to report, students may receive no quality science instruction at all in the elementary schools.

Surveying that, we have made a proposal to identify specialists for the teaching of science, and we propose the creation of rooms in seven elementary school buildings. Each equipped with teachers to address science instruction for all of the students. The students will then be scheduled to the resource rooms for science instruction. Pilot schools are currently being planned for 1984-85 school yea.

We turn now to middle and secondary schools. The middle school science education is plagued by additional quirks of the credentialing process. The middle schools are an area in which teachers both certified at the elementary and the secondary level are allowed to teach and, as a result, middle school science is often taught by teachers with elementary certification and much of what is just raised also applies. Because the formal training is limited, there is strict reliance on the textbook for direction. Laboratory experiences, when conducted, involve complex apparatus purchased specifically for certain demonstrations.

Science is being taught as a quest for final truths rather than a series of best possible answers to natural phenomena or questions. As technology advances, instructional changes must wait until the next textbook adoption. This leads secondary science instructors to teach with a false set of assumptions. They assume the students have learned the basic prerequisites for biology, chemistry and

physics and that they hold a basic scientific viewpoint and stance in approaching data and the world.

Grouping for instruction is either difficult to achieve in these conditions or nonexistent. The result in our own district is a proliferation of science courses, often with overlapping objectives.

In cooperation with the University of Pittsburgh, the Learning Research and Development Center, we have submitted a proposal to the NSF to fund a 3-year training program for middle school science teachers. If funded, the project will identify those concepts which are essential in the middle school grade levels and the most effective means of teaching those concepts.

Finally, with respect to secondary teaching in Pittsburgh, we have observed that the average high school teacher has been teaching for 15 years, 11 of them in the same building. He or she has completed a master's degree but, again, on the average that was more than 7 years ago.

There are no requirements for continuing education for Pennsylvania certification. To meet the needs of secondary school teachers, the school district has established a teachers' center at the Schenley High School in the heart of the city. Over the 5-year life cycle, every secondary teacher will be required to attend the center and participate in an 8-week minisabbatical during which they participate in seminars and course work; and be involved in independent research and clinical experiences, as well as content and curriculum updates in their own field of study.

This is our vehicle for addressing a need to obtain the kind of time with secondary teachers that are required to undertake the sort of in-service training that we need to take.

Finally, let me highlight four recommendations that we would like to propose to this committee:

First of all, we recommend increased Federal support for the purpose of assisting LEA's but, in particular, in the area of teacher in-service programs. The cost of the program such as the Schenley High School Teachers' Center is approximately $1.6 million over and above the normal expenses for that comprehensive high school. Local resources support this initiative at a time when Federal dollars are coming to Pittsburgh at a reduced rate, approximately 25 percent reduction over the last 3 years. The level of State funding over the past 5 years has gone from 40 percent to 32 percent. While we agree that new and better qualified teachers are a necessity, given our situation we are vitally concerned about the in-service of our present teachers. They will be teaching our young people for at least another 10 to 15 years.

No. 2, we recommend greater advancement of the LEA's in the design of the National Science Foundation grants for pre-college programs, particularly those awarded to higher education institutions. The history in this area is dotted with cures for ills long before they have been properly diagnosed.

No. 3, we recommend consideration of increased scientific understanding for all citizens regardless of their mission in life. While more scientists and engineers are needed to enhance technology, a well-educated citizenry is a necessity in order to establish and inform consumers for that technology.

Fourth and finally, we recommend that the National Science Board proposal for regional science centers to educate teachers, students, and parents alike be undertaken and given strong recommendation to this committee.

We have also appended an abstract for such a center designed by Pittsburgh teachers as an appendix to our testimony.

Thank you.

[The prepared statement of Dr. Herman follows:]

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
HEARING

TESTIMONY OF STANLEY J. HERMAN
ASSISTANT SUPERINTENDENT FOR
INSTRUCTIONAL DEVELOPMENT
PITTSBURGH BOARD OF EDUCATION

10 February, 1984
Pittsburgh, Pennsylvania

MATHEMATICS AND SCIENCE EDUCATION IN PITTSBURGH: A STATUS REPORT

Recently, dozens of blue ribbon commissions and distinguished scholars have published status reports on the health of American public school education. The focus of the hearing today is specifically on the status of science and mathematics education. The premier study of those areas was that of the National Science Board Commission on Precollege Education in Mathematics, Science, and Technology. The report entitled "Educating Americans for the 21st Century," documented deficiencies and made recommendations in many major areas affecting the quality of instruction. This report will be a short status report on those areas as they relate to the Pittsburgh Public Schools.

CURRICULUM

In 1980, the Pittsburgh Board of Education identified increased student achievement as their top priority. The major programmatic effort which has been initiated to promote student achievement in the basic skills areas is the Monitoring Achievement in Pittsburgh (MAP) program. The MAP program seeks to integrate instruction and testing through the specification of instructional objectives which form the core of the curriculum. Students' achievement on each of the objectives is then measured by frequent testing with instruments which are linked directly to the instruction. The tests are scored by computer, and the results returned to teachers within 10 days for their use in planning instruction. The result is a program which seeks to focus all partners to the educational enterprise (teachers, students, and parents) on clearly stated learning outcomes. Further, the MAP program provides diagnostic information regarding students' performance. This permits teachers to adjust instruction in appropriate fashions to assure that all of the desired outcomes are obtained.

Currently, MAP is fully operational in three academic areas: mathematics, grammar/composition, and reading. In addition, a pilot program is underway in the area of Critical Thinking. This latter program is scheduled for full adoption in the 1984-85 school year. Development of the project in each of these curricular areas has followed the same pattern. First key skills are identified for each grade level. Next, these skills are described in terms of instructional objectives, and appropriate teaching materials are identified for each objective. Finally, test items are developed to assess each of the objectives. Pilot efforts to evaluate items and testing procedures are undertaken before full implementation in each subject area.

As a result of our Monitoring Achievement Program and related staff training, we are pleased to report that our achievement scores are climbing. This year, 71% of our students in grades 1 to 8 scored at or above the national norm in mathematics. This is compared to only 57% three years ago. Each percentage point increase reflects the scores of approximately 210 students. Thus, the increases in this year's scores mean that 2900 students have moved above the national norms in the past three years.

Last year was the first administration of standardized tests to students enrolled in elective mathematics and science courses at the secondary level. The results by subject are included in an appendix attached to this document. The results establish two goals for secondary mathematics and science in Pittsburgh. First, we must increase the percentage of students scoring at or above the national average. Second, we must increase the percentage of students enrolled in those elective courses.

Currently, we are involved in extending the MAP mathematics program into the secondary schools; focusing the program on higher order thinking skills; and facilitating the movement of students to increasingly more difficult objectives when they achieve mastery of their present levels.

Curriculum work to establish grade level objectives in science and technology education began this year. We envision a continuous revision of those objectives over the next several years. Input in this process has been solicited from an advisory group consisting of representatives of local universities, industry, and professional scientific organizations.

TEACHER INSERVICE

Elementary Schools

Elementary school teachers usually have very little formal training in the teaching of science. They are uneasy and inadequate when student interests and questions exceed their knowledge; e.g. if worms don't have legs, how can they move? Curiosity and creativity are stifled when questions are not answered. Even worse, incorrect information is often taught which must then be unlearned later. Tragically, several studies have shown that students rank science as their favorite subject at the beginning of the third grade. The preference, however, steadily declines until science is ranked as the least favorite subject of ninth grade students.

Science has often been relegated to "back burner" status. Under the banner of back to basics and the press for increased mathematics and reading performance, time allotted to science teaching is often usurped. In some schools, students may receive no quality science instruction at all.

We propose the creation of science resource rooms in all elementary school buildings. Each room would be equipped with resources and a highly trained teacher. Students will be scheduled into the resource room for instruction. Pilot schools are planned for the 1984-85 school year.

Quality science teaching cannot survive without the support of the principal. Principals, therefore, will be trained to assess the quality of their science programs and devise plans to increase their effectiveness. Inservice for all elementary principals is scheduled to begin in March of 1984.

Middle and Secondary Schools

Middle school science is often taught by teachers with elementary certification. Since their formal training is limited, there is a strict reliance on the textbook for direction. Laboratory experiences, when conducted, involve complex apparatus purchased specifically for that demonstration. Emphasis is usually on the "correct results" rather than the process of gathering data to support conclusions. Science is taught as a collection of "final truths" rather than a series of the "best possible answers" to natural phenomena or questions. When technology advances, instructional changes must wait until the next textbook adoption.

Secondary science instructors teach with a set of false assumptions. They assume that students have learned the basic prerequisites for biology, chemistry, and physics. Grouping for instruction is either difficult to achieve or non-existent. A result is a proliferation of science courses which often have overlapping objectives. Personal satisfaction usually results only from the exceptional achievement of a few.

In cooperation with the University of Pittsburgh Learning Research and Development Center, a proposal has been submitted to the National Science Foundation to fund a three year training program for middle school science teachers. If funded, the project will identify those concepts which are essential at those grade levels, and the most effective means of teaching those concepts.

In Pittsburgh, the average high school teacher has been teaching for 15 years, 11 of them in the same building. He or she has completed a master's degree, but again, on the average, that was five years ago. There are no requirements for continuing education for Pennsylvania certification.

To meet the needs of secondary schools, the school district established a teacher center at our Schenley High School, a fully operating comprehensive high school in the heart of the city. Over the five year life of the center, every secondary teacher in the district will be required to attend.

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Each teacher will participate in an eight week "mini-sabbatical" during which they will be involved in seminars and classes, participate in a clinical training program, conduct independent research, and/or engage in one of a variety of externship placements.

It would not be fair to end this part of my testimony with the impression that we do not have many outstanding science and mathematics teachers. The Pittsburgh Public Schools has consistently produced its share of National Merit Finalists, Chemistry Olympics, and American Chemical Society Contest winners, as well as other meritorious recognition. It is just that we recognize much more to be accomplished.

GRADUATION REQUIREMENTS

Students in the Pittsburgh Public Schools are awarded differentiated diplomas. The minimum requirements are two units in mathematics and two units in science. The academic diploma requires an additional mathematics course, but most students also elect an additional science. With the freshman class of 1985, all students will need three units of each for graduation. This is summarized below:

PITTSBURGH PUBLIC SCHOOLS GRADUATION REQUIREMENTS

	Present Minimum	Present Academic	Proposed 1985
English	4	4	4
Mathematics	2	3	3
Science	2	2	3
Social Studies	3	3	3
Electives	8	7*	8**
Total	19	19	21

* Foreign Language --2
Fine Arts --1
Academic Electives--1
Optional Electives--3

** Arts or Humanities--2
Optional Electives--5
Physical Education--1

Physical Education must be taken during each of the years in all options, but credit is awarded only with the 1985 option.

RECOMMENDATIONS TO THE COMMITTEE

1. We recommend increased federal support for the purpose of assisting LEAs in teacher inservice programs. The cost of the Schenley High School Teacher Center is approximately an additional 1 1/2 million dollars each year. Local resources support the initiative at a time when federal dollars coming to Pittsburgh have been reduced by approximately 25% over the last three years. The level of state funding over the last five years has gone from 40% to 32%. S.B. 2743 of the 97th Congress would have been particularly helpful. While we agree that new and better qualified teachers are a necessity, we are vitally concerned about the inservice of our present teachers, who will be teaching our young people for at least another fifteen years.

2. We recommend greater involvement of LEAS in the design of National Science Foundation grants for precollege programs awarded to higher education institutions. History is well documented with university cures for ills before they have been properly diagnosed.

3. We recommend the consideration of increased scientific understanding for all citizens regardless of their mission in life. While more scientists and engineers are needed to enhance technology, a well educated citizenry is necessary to establish informed consumers of that technology.

4. We recommend the National Science Board proposal for regional science centers to educate teachers, students, and parents alike. An abstract of such a center, designed by Pittsburgh teachers, is included as an appendix.

APPENDIX A

PITTSBURGH PUBLIC SCHOOLS

SUMMARY OF HIGH SCHOOL
MATHEMATICS ACHIEVEMENT SYSTEM-WIDE

	Subject/ Population	Number Tested	Percent Scoring At or Above National Norm	Percent Scoring In The Bottom Quarter Nationally	Percent Scoring In The Middle Half Nationally	Percent Scoring In The Top Quarter Nationally
1.	Algebra 1 All Students	1730	64%	15%	49%	36%
2.	Algebra 1 Scholars Only	388	96%	1%	22%	77%
3.	Basic Algebra 2* All Students	557	39%	22%	68%	10%
4.	Algebra 2 All Students	976	54%	16%	58%	26%
5.	Algebra 2 Scholars Only	329	80%	5%	34%	61%
6.	Calculus All Students	113	70%	16%	26%	58%

*Basic Algebra 1 and 2, a two-year course of study covering the content of first-year algebra, is designed for students who would have difficulty completing successfully a regular one-year algebra course. Students in Basic Algebra 2 receive the same test given to students completing the one-year algebra course.

APPENDIX B

PITTSBURGH PUBLIC SCHOOLS

SUMMARY OF HIGH SCHOOL SCIENCE
ACHIEVEMENT SYSTEM-WIDE
TESTS ADMINISTERED MAY 1963

	Subject/ Population	Number Tested	Percent Scoring At or Above National Norm	Percent Scoring In The Bottom Quarter Nationally	Percent Scoring In The Middle Half Nationally	Percent Scoring In The Top Quarter Nationally
1.	Physical Science All Students	1701	32%	35%	54%	11%
2.	Biology All Students	2720	24%	43%	46%	9%
3.	Biology Scholars Only	483	74%	5%	55%	40%
4.	Chemistry All Students	1232	26%	47%	43%	10%
5.	Chemistry Scholars Only	372	56%	21%	51%	28%
6.	Physics All Students	617	34%	40%	49%	11%
7.	Physics Scholars Only	367	42%	31%	53%	16%

APPENDIX C
PITTSBURGH PUBLIC SCHOOLS

GENERAL GOALS FOR SCIENCE AND MATHEMATICS EDUCATION

The general goals for science and mathematics education should include:

1. teaching for literacy in science and mathematics.
2. teaching for adaptability in an increasingly technological society.
3. teaching for constructive and productive citizenship in a technological society.
4. teaching to encourage student interest in science and technology as professional and vocational career choices.

ACHIEVING THE GOALS FOR SCIENCE AND MATHEMATICS EDUCATION

The Problem

Since science and mathematics education has been long neglected on local, state and national levels, it has not kept pace with scientific and technological advances in the society at large. Further, training of science and mathematics teachers, curriculum development, and the use of appropriate technology in the science and mathematics classrooms, have received little attention and do not reflect the state of the art in science and technology. The outcome of such neglect and lack of attention is a factor in decreasing enrollment in science and engineering courses at the college level and a population lacking in the technological skills and understandings required for job placement in a highly technological society.

Suggestions for Addressing the Problem

1. Provide support for the Schenley Teacher Center experience with additional opportunities for research, peer teaching, and idea exchange.
2. Establish minimum competencies K-12 in science and math and develop a curriculum which provides an incremental teaching of major concepts, skills, and analytical thinking.
3. Provide opportunities for science and mathematics teachers K-12 to study and discuss teaching problems and their solutions with scientists from industry and universities.

Suggestions for Addressing the Problem (Continued)

4. Encourage partnerships between schools and industry which focus on the needs of science and mathematics education.
5. Provide a forum of expertise for the planning, development, and staffing of K-12 science and math enrichment programs.

THE PITTSBURGH INSTITUTE FOR TEACHERS OF SCIENCE AND MATH

An institute is proposed to provide leadership in meeting identified needs in science and math. Pittsburgh science teachers have recommended the following programs and services.

1. Workshops/Seminars: It is recommended that programs be modeled after the National Science Foundation Institutes for science and mathematics teachers. They could provide in-depth, hands-on experiences with science and mathematics curriculum and process. The workshops would provide instruction and up-dating in scientific and technological advances as well as in methods and strategies for teaching science and mathematics. Suggested topics for workshops/seminars include:
    a. development of a K-12 science and mathematics curriculum
    b. development of laboratory exercises and investigations in science and mathematics which exemplify the inquiry process
    c. development of teaching modules for special topics in science and mathematics
    d. integration of the science and mathematics curriculum with instructional programs in the practical arts
    e. review of new and special topics in science and mathematics
    f. technological innovations
    g. developing teacher computer literacy
    h. computer assisted instruction
    i. curriculum review, evaluation and revision
    j. review and evaluation of curricular materials and teaching aids

2. Lectures/Colloquia: The frequency of such programs would depend on teacher needs and interest. The following recommendations are made:

    a. current research in science and mathematics teaching relating to such issues as the sequencing of instruction.
    b. system-wide, discipline-based, meet and discuss sessions relating to problems and needs of science and mathematics education and teaching.
    c. presentations by guest lecturers on special topics in science and mathematics. Lecturers could be recruited from local colleges, universities, businesses and industries.

3. Informational Services: It has been recommended that the Institute provide:

    a. a professional library including textbooks, reference books, information retrieval systems including access to computer data banks.
    b. dissemination of materials, modules and curricula developed in center workshop.
    c. dissemination of journal articles or research reports of interest to teachers.
    d. video tapes of special programs, films, lectures by district teachers or by visiting scientists, engineers and technicians.

4. Equipment and Supply Center: The difficulties attending the purchase of expensive and infrequently used equipment and supplies could be surmounted by purchasing such items on a system basis and distributing them on a call and pick-up schedule.

5. Demonstrations and Displays: Science and mathematics equipment and supplies, as well as teaching aids, would be demonstrated and displayed by company representatives to aid teachers in evaluating such items for possible purchase.

6. Special Events and Programs: The Institute would become the center for:

   a. adult discussion groups of issues and topics in science and technology.
   b. adult education in science, technology and mathematics.
   c. programs to help parents help their children learn science and mathematics.
   d. activities such as those sponsored by the American Chemical Society Education Committee and the Council of Mathematics Teachers.
   e. special student programs such as science and mathematics conferences or lectures by visiting scientists, mathematicians, and engineers.
   f. development and production of science and mathematics teaching kits for elementary science and mathematics.
   g. meetings and discussions between teachers and practicing professionals in science, mathematics, and related fields.
   h. staging system-wide participation in the Buhl Science Fair, Junior Academy of Science, Pittsburgh Engineering Program, Superbowl of Problem Solving, Math Olympics, and the American Chemical Society Contest.
   i. developing a city-wide network of science and math mentors who will sponsor exceptionally able students with original research.

Mr. WALGREN. Thank you very much. We appreciate that. Those are very direct suggestions.

Let's turn to Miss Joyner.

Ms. JOYNER. Thank you, Congressman Walgren.

My name is Shirley Joyner and I am presently board president for the school district of Penn Hills.

School board members volunteer their time and we are elected and serve without pay. We do so because we realize that the next generation is our most important set and we want to participate in preparing them for the challenges that lie ahead.

Penn Hill, perhaps, typifies most of the school districts in the Nation. We have experienced a key decline in student population, an eroding tax base which I am attempting to provide our schools with programs to meet their needs in an ever-developing technological area.

As a school board member, I would like to present some perspectives as to ways by which we might begin to prepare education in the science and math areas, some of which are frayed.

Your current focus and debate on education in helping to identify some of the problems such as the hiring that you are having to take certainly is a step in the right direction.

Second, changing the attitudes of the public toward education, we know how difficult it is to change attitudes, however it can be done. The public must begin to demand excellence from our children, the schools, teachers and school boards.

As you all know, children will do what is expeted of them. If it is mediocrity, that's what we will get. If it's excellence, we can get that as well. One way that we might begin to change attitudes in elementary and junior high school students might be by way of contests, contests in math and science similar to those of the national spelling contests. So far, it has not cost you anything or certainly from those first two, the costs would be very minimal.

However, the next area will begin to require some funding.

In order to develop in science and math, the student must be able to read. There should be grants to develop skills of teachers so that they will be able to teach our children to read.

My next focus and my main focus is in the area of orientation and development of technical skills where efforts must be addressed so that teachers will be able to give the students the necessary skills around competencies which will make them competitive in the future marketplace.

My perception as a board member indicates that a stronger and closer tie is needed to be developed between industry and education. These ties could be in the form of CETA, like programs for math and science teachers. By this I mean that Federal legislation which would allow tax incentives for industry who would hire the science teachers for the 3 months from the summer when school is not in session, thereby helping topnotch science and math teachers supplement their salaries and at the same time allowing them to keep their skills current on the scientific and mathematical application of theory being implemented in the programmatic world of work.

At the student level, other options for joint efforts between education and industry can be explored. For example, student fellow-

ships could be extended so that students might be able to work in industry in the areas of math and science. Such programs could be based upon a similar structure to our vocational distributive education options and would provide onsite application experience.

Payment for such work could not be the form of scholarships or scholarship aid to the math and sciences oriented students.

These programs would have to be jointly defined between particular industries, institutions of higher learning and low-cal school districts.

The second area of cooperation between business, industry, and education could be undertaken in the development of comprehensive examinations based upon clearly established content roles that would result in varying degrees for students to participate in scholarship activities. The funding of which could come from business in industry.

And finally, another approach might be to expand an advanced placement course offerings in math and science whereby utilizing the funding for such courses could be based upon the funding formulas similar to those now in application in the special education areas.

I believe that initial steps have been undertaken in western Pennsylvania through the math and science academies to encourage a linkage of education to business and industry. It is my belief that a stronger affiliation between public education, institutions of higher learning and business and industry must coexist in order that students may be provided with a basic background and fundamental skills and knowledge that will facilitate movement to either direct industry employment from a high school or technical program or agencies to a college program that is designed to meet the future needs of the marketplace provided within our free enterprise economic system.

Thank you for the opportunity to speak and I must say that this is my first, but I am very happy to have participated and to have heard all of the other presentations that have been made because it certainly is an important aspect to our educational beliefs.

[The prepared statement of Shirley Joyner follows:]

TESTIMONY PRESENTED TO THE

HOUSE SUB-COMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

by

Mrs. Shirley Joyner, President

Penn Hills Board of School Directors

COMMITTEE ON SCIENCE AND TECHNOLOGY

Gentlemen, my name is Mrs. Shirley Joyner, and I am currently Board President for the Penn Hills School District. Penn Hills operates comprehensive programs for students in kindergarten through grade 12 covering basic education, special education and vocational education. Penn Hills, perhaps, typifies many of the factors which are affecting most school districts within the western Pennsylvania area, the State of Pennsylvania and the nation, in general.

Since 1974, our district has experienced over a 42% reduction in the number of students which we currently serve. Many factors may be identified as contributory to this phenomena, but the bottom line is that local districts and school boards must attempt to provide continuing programs to meet student needs in an ever-developing technological era with a tax base that is not growing at the same rate as previous levels of inflation. Our district has been fortunate to maintain both a good quality of student body and high caliber teacher. The problem which does exist, however, is that with the declining student population, the district has also experienced the need for reductions in teaching staff. This means that in our district, the general level of experience for teaching staff is at 10 or more years. An additional concern is that continuing student declines are anticipated over the next several years based upon our most current and accurate projections. Reduction in teaching staff will undoubtedly be a continuing problem to be faced. Combined with the more mature staff is the phenomena of a more rapidly expanding technology in the math and science areas. Such technological revolutions present coordinatory problems in maintaining professional levels of preparation for all staff employed within the district. Students do continue to receive high quality instruction in the basic skills of reading, writing, spelling, etc. It is in the orientation to the technical based topics and fields where efforts must be addressed to provide expanded opportunities for students to gain both skills and competencies which will make them competitive in the future marketplace.

Our district has always supported a broad-based educational program with requirements for graduation that exceeded State minimums. We are supportive of those directions being taken by the Governor, the State Board of Education and the legislature in affirming a commitment to excellence in education.

Hearings such as these have focused public attention to a problem and they help to develop an attitude of understanding by the general populace that emphasizes the single most important resource of any community, state or nation is its human potential. The concentration of finances to develop a nation's human resources is, I believe, the single most important value that can be held by society.

At the elementary school level, continuation of a commitment to excellence in the acquisition of basic skills is desired. The ability to read and the commitment to teach reading is a prerequisite to unlocking the doors into science and math. This should continue. It is also perhaps desirable to create a system either locally, regionally, state-wide or nationally to recognize student excellence in the acquisition of scientific knowledge. (This could be similar in structure to awards currently granted in the arena of athletics, i.e., Dial award, Heisman trophy, etc.)

My perception as a board member indicates a stronger and closer tie needs to be developed between industry and education in both identifying competencies, areas of expertise and a commitment to funding such programs. Funding could be undertaken at both a teacher level and a student level. For example, at the teacher level, it would be desirable to be able to attract and hold highly gifted scientists and mathematicians who could have a level of expertise in the instructional programs that would maintain current competency with the technological revolution. Commitments from industry could coordinatorily be scheduled to provide a continuing summer level of employment in technologically related field experiences. This would provide a competitive salary base with industry, which is now drawing many mathematicians and scientists from the educational arena, and still keep the staff member current on the scientific and mathematical applications of theory being implemented in the

pragmatic world of work.

At the student level, other options for joint effort between education and industry should be explored. For example, student fellowships could be extended to work in industry in the areas of math and science for outstanding students. Such programs could be based on a similar structure to our current vocational education/ distributive education options and would provide on-site application experience. Payment for such work could be in the form of scholarships or scholarship aid to the math and science oriented students. These programs would have to be jointly defined between particular industries, institutions of higher education and local school districts.

A second area of cooperation between business, industry and education could be undertaken in the development of comprehensive examinations based upon clearly established content objectives, the results of which would produce varying degrees of scholarships or aid based upon student performance (and any other factors as may be identified) with funding of such scholarship aid coming from business and industry contributions. Such contributions could, of course, be a tax deductible incentive for private enterprise participants. Such examinations could be developed through the joint efforts of industry, educational institutions, or state and national government educational agencies. Such examinations should be comprehensive and rigorous - and reward student effort in the acquisition of mathematical and scientific technical knowledge.

Other approaches might also be investigated in encouraging school districts to expand advanced placement course offerings in the math/science areas by utilizing excess cost funding formulas similar to those now in application in the special education areas. These might particularly be applied to incentive grants targeted toward gifted education or to students who could qualify and maintain a high level of performance in advanced placement courses.

There have been, to my understanding, initial steps undertaken through

mathematics and science academies in western Pennsylvania which have addressed a long range plan to improve these areas by identifying current exemplary projects and attempting to encourage a business/industry linkage to education. It is my belief that a stronger affiliation between public education, institutions of higher learning, and business/industry must co-exist in order that students may be provided with the basic background and fundamental skills and knowledge that will facilitate movements to either direct industry employment from a high school or technical program, or access to a college program that is designed to meet the future needs of the marketplace provided within our free enterprise, economic system.

Thank you for the opportunity to present a point of view from a school board member.

Mr. WALGREN. Yes. There are a lot of kids out there who depend on our doing the best by them, particularly when you think of the gap between the society pickup in jobs and industry and the educational system, I think, so often we hold out promises that then are either not filled and great disappoints occur or we just are not really filling in that transition so that there is a relevant skill.

I certainly appreciate your participating on that fundamental point that you make.

Father Lang. Welcome.

Reverend LANG. I will talk about the course offerings in the elementary and secondary schools in the Catholic Diocese of Pittsburgh in mathematics and science and some observations on the programs, the manner in which they are taught, the outcomes and the achievements of students.

I think it is necessary to say in the beginning that the course offerings do not seem to be the problem. Schools everywhere are offering calculus, physics, computer literacy, and other programs that give young people insight into the areas of math and sciences intended to prepare them for college and university training and I think the previous testimony people here have indicated the concern about curriculum.

There is obviously a shortage of math and science teachers. There is also a universal shortage of good teachers. Teaching requires people who are prepared to give the time and put forth the effort to challenge and inspire, not just to teach the course offerings. True education creates curiousity, a sense of inquiry and the ability to reason through a problem. Such a disposition is basic to the process of learning. Obviously, money can be thrown at this problem, but it is a readiness question rather than a program problem. Imaginative teachers must be attracted by the satisfaction inherent in teaching and by the respect the community offers to a teacher.

Today there is little reason for a young man or woman to enter the teaching profession. If we are to attract quality people to edu-

cation, we must enable our young people to see that achievements are possible to them, not only financially, but personally.

In the narrative which accompanied your letter, there was concern by students in our schools not being of the same quality or attaining the same achievement levels as students of Japan, West Germany, and the Soviet Union. This is probably a very valid observation.

It is necessary, however, to see that our goals for education are different. In the United States we have compulsory education. Young men and women are required to attend school until they are 16 or 17 years of age. The purpose of our educational program is not only to create scientists and mathematics, but our philosphy of life and political structure demands a broad-based education program as a means of improving the quality of life for our citizens. In a democratic society it is necessary that we have an informed citizenry and compulsory education, although there are many drawbacks connected with it as a means by which we obtain that.

It is intended to provide a level of education that will result in a good and informed citizenry along with growth and scientific expertise.

I would hope that no one would want to exchange intense scientific education for a few for the appropriated education of all. Hopefully, we would be able to accomplish both goals, education for an informed citizenry and the development of schoiars, researchers, and scientists to enable us to maintain our place in the world market which provides for our national security.

Previous testimony in alluding to the Soviet Union and to Japan talked about the tremendous progress that had been made educationally in those areas. I think that we fail to realize that they are dealing with a very limited number of people and that the educational programs within the United States, whether public or private, are dealing with a very broad spectrum of the population and that in dealing with such large groups of people and varying degrees of ability there are inherent problems.

It is necessary, however, to recognize that as world leaders not only in the political but economic arena that it is necessary to provide scientific leadership as well as to maintain our quality of life. We may have reached the point in our society where if we are to maintain economic development and national security, we have to place the responsibility for technical education upon the corporations requiring them to provide workers with the specific technical training that is necessary to accomplish very specific tasks necessary for their manufacturing process.

Education is primarily for fullfilment and the development of the individual. Math and science are but a small dimension of true education. A person must be able to appreciate art, music, literature, and the knowledge of history that will make life meaningful. As important as math and science are, economic and national security education should not be identified with competency in scientific areas.

The educational program is motivation and expectation. Does society judge education to be important? What message does our society communicate about the value of education. What is the impact of the weakening family structure on the process of education? Is

there anyone here that cannot attribute much of the motivation for their success to a mother and father and teacher and the value their parents associated with education? In our society where there is a breakdown of the family unit, not only is the family in trouble, but education is in trouble as well. In many family units the pursuit and motivation of achievement have been removed by the breakdown of family structures.

Expectation is a critical part of education. Someone once said, aim at nothing and you will hit it. In many cases we do not create goals for our young people. If there are no goals, what is there for our young people to obtain. Do educators set appropriate goals for all students, not just for nuclear physicists, but for the student who is going to struggle with world geography for the basics of reading, writing, arithmatic, and reasoning. Have minimum goals become the maximum level achievement? I do not think that we are setting the appropriate expectations regarding behavior nor for academic achievement. We must motivate all students in areas of math and science. We must help teachers by staff developent programs which would assist them and motivate them as teachers. The National Science Foundation programs for math and science teachers as they existed in the past were a great source of assistance to teachers and inspiring outcomes of math and science programs that were carried over into the classroom.

Everyone seems to be talking about the National Science Foundation and although I am a few years removed from the area of principalship involved in curriculum development, I honestly believe that the National Science Foundation was out of business. I have not heard much about them for so long and the point that was made previously that the Congressman made that may be the involvement of the National Science Foundation is at a level that it is not impacting upon the classroom achievement. I can remember 10 or 15 years ago that teachers were attending National Science Foundation programs every summer and would come back highly motivated with new insights and new ideas and I simply have not heard about that kind of outcome in recent years.

Programs for students such as the Junior Academy of Science at Pennsylvania State funded organization stimulates and promotes interest in the development of research projects and personal investigations. I think it would be a mistake to put more demands upon school curriculum. Programs are sufficient to prepare students for college. Emphasis must be directed at increasing motivation and expectation of students and teachers so that we will value learning rather than to see it as a commodity for economic gain.

[The prepared statement of Father Lang follows:]

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TESTIMONY TO COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

February 10, 1984

David L. Lawrence Convention Center
Pittsburgh, Pennsylvania

Gentlemen:

I will attach to my testimony the course offerings in the elementary and secondary schools of the Catholic Diocese of Pittsburgh in mathematics and science and some observations about the programs, the manner in which they are taught, the outcomes and the achievements of the students.

I think it is necessary to say in the beginning that the course offerings do not seem to be the problem. Schools everywhere are offering calculus, physics, computer literacy, and other programs that give young people insight into the areas of math and science intended to prepare them for college and university training.

There is obviously a shortage of math and science teachers. But there is also a universal shortage of good teachers. Teaching requires people who are prepared to give the time and to put forth the effort to challenge and inspire not just to teach the course offerings. True, education creates curiosity, a sense of inquiry, and the ability to reason through a problem. Such a disposition is basic to the process of learning. Obviously money can be thrown at this problem, but it is a readiness question rather than a program problem. Imaginative teachers must be attracted by the satisfaction inherent in teaching and by the respect the community offers a teacher. Today there is little reason for a young man or woman to enter the teaching profession. If we are to attract quality people to education, we must enable our young people to see that achievements are possible to them not only financially but personally.

TESTIMONY TO COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES - February 10, 1984

page two

In the narrative which accompanied your letter, there was concern about students in our schools not being of the same quality or requiring the same achievement levels as students of Japan, West Germany or the Soviet Union. That is probably a very valid observation. It is necessary, however, to see that our goals for education are different. In the United States we have compulsory education. Young men and women are required to attend school until they are sixteen or seventeen years of age. The purpose of our educational program is not only to create scientists and mathematicians but our philosophy of life and political structure demands a broad based educational program as a means of improving the quality of life for our citizens. In a democratic society, it is necessary that we have an informed citizenry and compulsory education although there are many drawbacks connected with it. It is intended to provide a level of education that will result in a good and informed citizenry along with growth in scientific expertise. I would hope that no one would want to exchange intense scientific education for a few for the appropriate education of all. Hopefully, we would be able to accomplish both goals: education for an informed citizenry and the development of scholars, researchers and scientists to enable us to maintain our place in world markets and to provide for our national security.

It is necessary, however, to recognize that as a world leader, not only in the political but economic arena, it is necessary to provide scientific leadership as well as to maintain our quality of life. We may have reached the point in our society where if we are to maintain economic development and national security, we may have to place the responsibility for technical education upon corporations, requiring them

to provide workers with the technical training that is necessary to accomplish very specific tasks necessary for their manufacturing process.

Education is primarily for the fulfillment and development of the individual; math and science are but a small dimension of true education. The human person must be able to appreciate art, music, literature, and the knowledge of history that will make life meaningful. As important as math and science are, economic and national security education should not be identified with competency in scientific areas.

The educational problem is motivation and expectation. Does society judge education to be important? What message does our society communicate about the value of education? What is the impact of the weakening family structure on the process of education? Is there anyone here that cannot attribute much of the motivation for their success to a mother and father and to the value their parents associated with education. In our society where there is a breakdown of the family unit, not only is the family in trouble but education is in trouble as well. In many family units the pursuit and motivation to achieve has been removed.

Expectation is a critical part of education. Someone once said aim at nothing and you will hit it. In many cases we do not create goals for our young people. If there are no goals what is there for our young people to obtain? Do educators set appropriate goals for all students? Not just for the nuclear physicist but the student who is going to struggle with world geography and the basics of reading, writing, and arithmetic, and reasoning. Have minimum goals become the maximum level of achievement. I do not think that we are setting the appropriate expectations regarding behavior nor for academic achievement. We must motivate

all students in areas of math and science, we must help teachers by staff development programs which will assist them and motivate them as teachers. National Science Foundation programs for math and science teachers as they existed in the past were a great source of assistance to teachers in inspiring outcomes of math and science programs that were carried over into the classroom.

Programs for students such as the Junior Academy of Science, a Pennsylvania State funded organization, stimulates and promotes interest through the development of research projects and personal investigations.

I think a mistake would be made to put more demands upon school curriculum. Programs are sufficient to prepare students for college; emphasis must be directed at increasing motivation and expectations of students and teachers so that we will value learning rather than to see it as a commodity for economic gain.

HEARING ON SCIENCE AND MATH

SCIENCE:

Catholic secondary schools offer basic core curriculum in science education with revisions responsive to change and needs; the curriculum is more traditional and academic. Science staff is constant.

Environmental courses have been introduced in recent years as well as the two year science requirement for graduation. Academic students are scheduled for biology and chemistry and may choose other electives such as Chemistry II, Physics, honors courses, or Human Physiology. Course offerings differ with the schools. Other students are scheduled for Biology and Earth Science, or a science course of comparable difficulty.

The future trend of computer software for laboratory experiments offers a new world of laboratory experience actualized in a vacuum with no danger of spillage or threat of accident. The transition will take place slowly but the initial cost factor will balance the ever escalating cost of chemicals.

Laboratory experiences are first hand experiences - if they are in the laboratory setting or on the computer screen.

Emphasis in science education or mathematics has been and must be problem solving and critical thinking.

MATHEMATICS:

The curriculum in mathematics needs to be judged according to changing technology. Texts are reinterpreted to teach skills relevant to today's world. Computers free students to think and be accurate. Again, critical thinking and analytical thinking need to be emphasized so that accurate programs can be written.

We need to educate our teachers for the future of computers and all the possibilities of the present. Teachers need to feel qualified to teach these skills. Students of computer enter the job market, not education. Will certification for computer education be independent of mathematics?

Thought should be given to re-establish the National Science Foundation Grants. Continuing education is a solution to computer education.

Although Catholic secondary schools offer a total curriculum of mathematics offerings, including courses for college credit, we realize that, although mathematics has evolved through the ages, computer is the trend of the future. Computer education, with emphasis on computer ethics and development of communication skills is our thrust for the future.

NATURE OF SCIENCE EDUCATION IN THE PITTSBURGH DIOCESAN SCHOOLS

Science education in the elementary schools of the Diocese of Pittsburgh is essential to the total educational process. The Curriculum Guidelines as adopted by the Diocese stress the four interlocking dimensions of Science Education - process, concept, teacher, and student. The teacher provides a continuum of experiences for the students while at the same time the student has an opportunity and responsibility for planning investigations. The teacher creates a learning environment that is discovery-oriented while the student is creatively engaged in the learning process. Open discussion and interaction is encouraged.

Performance objectives are outlined in the Curriculum Guidelines to be completed at each of the three organizational levels - Primary (K-3), Intermediate (4-5-6) and Upper Elementary (7-8). These objectives include physical, earth, life and space science.

Because of the philosophy of our schools there is a strong emphasis on respect for life, care and conservation of natural resources, and societal ethical/moral issues of the times.

It is our goal to develop those skills that are basic to critical observation problem solving, decision making and values.

QUALITY OF SCIENCE EDUCATION

In October 1984 the Stanford Achievement Science test will be administered to fourth, sixth, and eighth year students. This will give us a standardized test to measure te outcomes of our Science objectives.

Presently, our evaluation is that our desired goals are being achieved. This is based on the fact that 80% of the students in a given class are making good progress and the remainder are improving. Observable evidence indicates that 80% of students progress to the limit of individual capabilities achieving mastery of performance objectives.

No measurable instrument except teacher made tests have been used since the 1981-82 school year.

Of significance is the fact that over 75% of 7th and 8th graders participating in the Junior Academy of Science and Allegheny and Westmoreland Counties are from the Pittsburgh Diocesan Schools representing 453 of the 591 students (1983-84 year) demonstrating interest, aptitude and achievement.

Consistently, our Diocesan participants receive 1st awards at the State level.

TIME ALLOTMENTS

Primary - 75 minutes per week

Intermediate

4th year - 145 minutes per week

5th & 6th year - 200 minutes per week

Upper Elementary

7th & 8th year - 200 minutes per week including lab

Suggestions:

Since the Pennsylvania Junior Academy of Science is a state-wide organization designed to stimulate and promote interest among Science students through the development of research projects and investigations, it is recommended that this organization be put on a permanent basis financially through state allocated funds as so other Academies do in so many other states. The year to year basis on which the Academy now rests hinders the expansion and growth of this organization.

Students participating in this program are encouraged to conduct scientific investigations, prepare a written report, and present an oral discourse on their findings at the Regional Meetings. At the Annual State Meeting the best papers from each Regional Meeting are presented. At both Regional and State Meetings papers presented are evaluated by a panel of judges.

Outstanding students from our schools are identified and receive encouragement to pursue a career in the scientific community through this organization.

NATURE OF THE MATHEMATICS PROGRAM OF THE PITTSBURGH DIOCESAN ELEMENTARY SCHOOLS

The Mathematics Curriculum of the elementary schools in the Diocese of Pittsburgh is based on today's need for the individual to define problems and discover creative ways to solve them. This need for abstract thought demands critical and analytical ability - and creative imagination to discover new questions. The curriculum seeks to maintain a balance between abstract mathematics and problem solving.

The Mathematics Guidelines adopted by the Diocese of Pittsburgh which contain levels ranging from Level A to Level Y are based upon a Continuous Progress Philosophy. Each level contains several objectives encompassing sets, numbers, and numerations; geometry and measurement; whole numbers operations and problems, rational numbers, ratio, probability, statistics, and graphing; proportion and percent; positive and negative numbers and the metric system. Algebra is taught to the students who have completed levels A-Y.

Upon the completion of a level each child is tested in the Continuous Progress Level Test for mastery before a new level is begun. Students move at their own pace usually within the group. However, grouping is flexible so that only students who have mastered the level move to the next level. Where a student does not master 80% of the objectives of a level he/she is given remediation until mastery is obtained.

QUALITY OF MATHEMATICS

We are happy to say that the quality of our elementary mathematics program as evaluated by the results of the California Achievement Test over a period of 4-5 years is excellent. Scores are consistently higher than the national norm. In terms of Grade Equivalent Scores the following are the results of 1983-84 October Testing.

Grade 2 - 2.4
3 - 3.3
4 - 4.3
5 - 5.5
6 - 6.7
7 - 8.0
8 - 9.3

The results of Standardized Testing and the observation of Educational Consultants in the field indicate that student and teacher quality is good.

Our greatest weakness is the result of financial restraints restricting our ability to create challenging programs for gifted children.

Results of the testing indicate that we do exceptionally well in meeting the needs of low ability and average students. Teacher In-Service, materials, and challenging, creative curriculum for gifted children necessitates financial aid especially in those school districts where our students do not have access to the districts gifted program.

Mr. WALGREN. Thank you very much, Father Lang. It was appropriate for you to go at the end in the overview that you gave from a whole perspective and I really appreciate that being part of the record.

Has anyone else had the same impression of the National Science Foundation not being in with the outreach business as Father Lang has said?

Dr. BLACKA. That is my feeling, too, yes.

Mr. WALGREN. Has it ever been said why that is the case in educational circles? Has that been commented on?

Dr. BLACKA. Not that I know of.

Reverend LANG. They seem to have disappeared. I was really surprised. Everybody that I have heard has mentioned it and I just presumed that they were not even functioning.

Mr. WALGREN. Well, there was a short hiatus starting in 1980 and 1981, but what you are saying is that they were not functioning before then either and certainly on a program matter view of their budget, you would think they were and you would wonder what that means.

Dr. LEMAHIEU. I wonder what a detailed examination of the sorts of initiatives that they were investing in might reveal. Most of what I have seen come along, or go past my desk, are the very sorts of things that really would not reach into my district in any event.

Mr. WALGREN. I see.

Would it be fair to say that all of you see potential for a Federal role like used to exist in that area or other kinds of bringing people together that would be stimulative although not costing millions and millions and millions of dollars on a program level? We struggle with this dichotomy where people say the Federal Goverment

ought not to be involved in education, period. It is true that there are many areas where we could make a little contribution that would be helpful in a pragmatic sense that would not overstep some of the local values that were emphasized in Dr. Blacka's testimony?

Dr. BLACKA. Yes. I think the money should be spent on people where they can work together to get their ideas formulated and an approach started. I would not encourage paperwork, detailed applications and competition for the grants, but that you make them available so that people of education can, when they see the problem, bringing their strengths to bear on it.

Reverend LANG. I think that is a good point. Grantmanship is really a way of life today and that the individual teacher on the local classroom level is not getting involved in that. The programs of the past were programs that were offered. You did not have to do something very sophisticated to become involved in it, so that I think the programs rather than people competing for the dollars that the programs should be developed in some way that they are available to the individual teacher.

There are organizations that are staying alive and you know it better than I do that because they are able to write grants and get those dollars and get through a summer and get through a year and start that process over again with little consideration for what is happening down the line.

Mr. WALGREN. So would it be right to say that the competition for the grants is so strict or there is such limited resources actually being distributed that it is of no real practical value to a local school community. What we need is some kind of a program where there at least would be some concrete certainty of participation as opposed to a great buy if they succeed in the grant competition. Am I right in hearing what you are asking for something that's available rather than sending the school districts out to compete against themselves for one in 100 being picked up and involved in a program and the other 99 having wasted their time for the effort?

Dr. BLACKA. That is correct.

In the work I do applications are faithfully filled out by teachers, hours of time devoted to prepare them and in a couple of instances I know of, say, 11 going in and we did not get any grants at all. It is discouraging.

The money that should be available should be available to people who can get together at the university in an academic year and a summer institute and meet with others from business, be taught courses by those who are in the major fields of science, mathematics and come back inspired to feed into the mission of the schools. Content, yes, but schools are made up of people, people with a mission and they have to have that local initiative. It is one of the things that has been good about the Federal money that was once called title I was that it moved towards a block grant concept. There is money there that we can work with in a local level attaching it to our own mission, more so.

Dr. LEMAHIEU. Two points have been raised that I think I would like to comment on. First is the grantsmanship issue. It is extremely distressing to put that much effort into the development of a proposal and get the impression that one lost it to people who are

professionals at doing precisely that, especially when it happens to be the case of a small school district or even a large school district which I can assure you has no professionals on staff. It is real disturbing to me to think that the legacy of the latter half of the 20th century might just be that the one skill which has been added to human knolwedge would be "grantsmanship," of all things.

A second point that you asked about, a much earlier point, the idea of fostering coalitions which I think is really necessary and is extremely important. It is not extremely expensive, it doesn't seem to me, but very necessary for practicing educators. I was smiling when I heard people talking about the computer assisted education and efforts of that sort, on the earlier panel. I have looked at quite a bit of CAI materials which have come out of shops comprised largely of technicians and people thoroughly enamoured of the technology, thoroughly enamoured of the computer resources available. It is beautiful stuff, high quality stuff, but not necessarily sound from a pedological standpoint and not really able to stand up in a classroom.

Now, how do you inform those people that you have to get together in the classrooms? I could go through examples in other areas where I see an awful lot of money and certainly an awful lot of effort being put in to produce products that just don't quite hit the mark because those coalitions don't necessarily exist.

Ms. JOYNER. Congressman, as a school board director, my concern is that with the declining enrollment our present staff is at 10 years of service or more so that concern then becomes in terms of the skills, the inservice that so many on the other panels have talked about in terms of how do we upgrade the technical skills that these older or more mature teachers would have. So, of course, that becomes a great concern.

I also participated with a committee in Penn Hills to write a grant in terms of the teacher center and, unfortunately, ours was good, but not good enough, and from what I can understand is once you are on the list of receiving grants, one is accepted, you have a tendency to receive more so that those who have never received are not likely to begin receiving them and I think that that is unfortunate.

The other thought, though, that comes to my mind, aside from that, is when I mentioned about a contest such as a national spelling bee or in science and math I can't help but think how much emphasis we place on sports and athletics. Right now Bill Frailick at the University of Pittsburgh who was a Penn Hills graduate, how nice it would be if we could give you 300 names of youngsters who have excelled in math and science. That would certainly be a dream to fulfill.

Thank you.

Mr. WALGREN. Thinking of the inservice training, the other teacher panels seem to say we would like more of that. From an administrator's standpoint, how do you think we are doing in providing time when there is energy to benefit from just a teacher training program or time? Are we doing well or not well?

Dr. LEMAHIEU. Not terribly well. Time is money. The current mode of thinking about teachers' time is such that any additional time that we want from our teachers, I should say for inservice

training and things of that sort is, money to us. I could relate a very unhappy anecdote. There was a recent science inservice given on a Saturday at the University of Pittsburgh, I believe it was, with the time paid and I think three teachers showed up for that. We are not doing as well as I would like, first of all, and I can't resist the opportunity to underscore the necessity of thinking, at least from our perspective, in terms of inservice.

I wish we were in the new teacher business, we are not. And I speak both for myself and for my own district, but also for collegues that I have spoken with in all of the great city schools. We are just not in the new teacher business so we have in house what it is that we need to work with and we need the opportunity to do that now.

Mr. WALGREN. A city of Pittsburgh's wide eligibile program, time paid and turn up three teachers?

Dr. LEMAHIEU. Yes. We could investigate that. I don't know about the extent of the publicity for it and that sort of thing, but yes, that is a fact.

Dr. BLACKA. I think the same thing is true in a district like ours. We look, with interest, at the Schenley Teacher Center or Staff Development Center. A smaller district can't put together a center like that, but I think a year and a half or so ago we realized that we didn't have the response to the staff development need that was there, named a staff development coordinator working on opening at least a physical location for staff development where teachers can be trained and over 250 of our teachers have participated in evening programs in computer science in order to bring them along. We are just not in the business anymore of recruiting new teachers. We deal with teachers of 10 and more years of experience, so it is a definite need more so that 25 years ago when I had an academic year with the National Science Foundation.

There was a lot of new blood coming to the district in addition to my presence with the experiences gained through the National Science Foundation. Those days are gone.

Dr. LEMAHIEU. Let me add also a comment on the nature of the time that is required for teachers' inservice. It is not the 2 hours after school This is not a problem which I think is properly addressed there. That is why our effort is the Schenley's Teachers Center which is an 8-week program. We won't go into detail, but I think you can easily get a sense of the type of effort both in terms of money and energies that are required. That is a huge effort. I don't know of any other districts in the country that have something both on a mandatory basis and covering that extensive a time up and operating. It is unique in that sense, but I have got to say it is the sort of time, that much time in a block. You can run your 2 hours after school things, I don't know for how long, and not catch up to what is happening in science and technology.

Mr. WALGREN. How long has that teacher center been there?

Dr. LEMAHIEU. It was developed over the last 2 years and opened this past September. So it is very new and the returns are very good on it.

Also, an additional comment. We are going to take care of our own teachers, obviously, first of all. It will take roughly 4 years to cycle all of our secondary teachers through that center at 8 weeks

per cycle. We have been contemplating opening it up as a demonstration school for people in the region. Obviously, if you are in a district with one secondary school, and there are many in this area, you don't up and build a teacher center of that sort.

Mr. WALGREN. Now, that teacher center is not just focused on math and science, but rather the whole range and you wonder whether you could not have a similar regional gathering focused on science and math.

Dr. LEMAHIEU. You could, and what I would say is that you have got to think in terms of a block of time, day in and day out for the semester, or the term, or something like that.

Mr. WALGREN. I see.

Ms. Bach?

Ms. BACH. Yes, I would like to ask Ms. Joyner a question. You made a comment regarding grants for teachers to relearn how to teach students to read.

Ms. JOYNER. Yes.

Ms. BACH. What I am curious is if the teacher college is presumably where some of these teachers came, whether it was 10 years ago, 25 years ago, or 15, do they offer any kind of retraining programs or come back and relearn some of the qualities or are they teaching new methods?

Ms. JOYNER. Someone probably on a day-to-day basis could answer that a little better, but I am thinking in terms of we are not hiring more teachers now. So if we are looking at teachers with 10 years of experience, they are the ones then who would have to be retrained. I do know, though, that in Pennsylvania, teachers are required to have a teaching certificate for reading. Some of the dates do not require that, but my concern there would be in terms of teachers that we presently have going back and getting that certificate.

Ms. BACH. Along the same line, my curiosity is if the teacher colleges in the State offer any opportunity for teachers 10 years out to come back and learn new skills?

Ms. JOYNER. I am not aware.

Dr. BLACKA. It is not advertised in that way so far as I know. The local districts are doing things like paying for their credits so that they will go back. We pay it for up to 57 credits at a certain reimburseable amount so that the teachers can go back and gain skills. We also provide them with small grants, but grants to go back and attain additional certification. So the school districts are encouraging it. The biggest help that I am aware of is the Alleghany County intermediate unit which is the service unit between the Department of Education at Harrisburg and the local district. They provide many teacher inservice courses which are designed for the teacher on the job, the one that is in the assignment at the present time.

Ms. BACH. I was just looking through the Mount Lebanon School District courses that were presented in science and some of the biology ones are very impressive and I wondered if the instructors for those courses use outside people to come in and add to the quality of the teaching or maybe bring some particular focus. Not every biology teacher has particular background in ecology and plant genetics and certainly there is a lot of activity in that area.

Dr. BLACKA. We have a number of people who come in from the community as a resource, but the mainstay for those advanced biology programs is the teacher. That is the person that makes it work. We feel as though presently those teachers have the subject content mastery to carry out the program.

Ms. BACH. Father Lang, I had a question regarding the quality of teachers in your diocese. When I was going through school, I particularly chose to go to a private school, a Catholic school. I did so at that time because at that time it was the highest quality of education in my area and there was a lot of the peer pressure that I did not care to be part of. I wonder if the peer pressure at a private school has varied over the years, if you can compare your dioceses to a public school? Are they about comparable at this time?

Reverend LANG. Are you referring to the peer pressure of upper level students competing with lower level students?

Ms. BACH. No; I would say social peer pressures.

Reverend LANG. I would have to think that that kind of pressure is basically the same at the public as it is at the nonpublic.

Ms. BACH. I suppose I was at an advantage and all the social pressures had not quite hit the private schools.

Reverend LANG. I think culturally we are basically dealing with the same questions and the same problems.

Ms. BACH. The other question I had is on the salary levels that a private school can offer teachers versus a public school system. I am more familiar with people I know who out of dedication have stayed with the private schools regardless of the salary. Dc you have any problem attracting qualified teachers because of the salary that you have to offer and cannot negotiate on?

Reverend LANG. On the secondary level, we have a salary schedule that that is not at parady with the public shool system, but is very close so on the secondary level, we do not experience problems on salary. On the elementery level, that is a more serious problem and a problem that we are dealing with at the present time as much out of necessity as out of choice. But there is a great controversy going on about the motivation of the teachers in our schools. There is no question that there are a lot of people there not so much because of the desire for financial gain, although that is a necessary part of their existence, but there is a blending of the opportunities that they feel they have there, an involvement in a mission and to some degree are willing to sacrifice a certain financial remuneration with that. Twenty years ago that was a very, very, very common situation. With the economy being what it is, though, that kind of sacrifice or commitment is not always as possible as it was in the past.

Ms. BACH. How has your enrollment varied over the last, say? 10 years? Do you see any upward swinging at this point now or is it continuing downward?

Reverend LANG. We have been stable for the past 2 or 3 years, but this area has experienced serious problems over the past 20 years. In Pittsburgh, public schools in 1960, they had an enrollment of 146,000 students. They are currently, I think, at 41 or 42,000. We cover a broader area than they do, but we have always more or less paralled them with attendance.

In 1960 we also had 147,000 students and at the present time, we have 47,000. So we have been affected by the drop in population, but also this area has experienced a lot of outgrowth of people leaving the community and going into other places. Like every place else, the population trends would indicate that secondary level is going to experience continued loss over the next 3 or 4 years.

Ms. BACH. I have one final question, if I may. In the distribution of ages or years of teaching in your dioceses are you experiencing the same trends as the public schools are in that most of your teachers at this point have several years in as opposed to new teachers coming in?

Reverend LANG. Yes; that is a common problem because there is no place to go. You want to be a teacher you stay there as a teacher and the openings have been very few and far between. We had one school in the South Hills area last year that normally would have a faculty of 65 teachers that did not have one turn over. So there is a very stable kind of situation, but we are also experiencing what everyone else is experiencing that the people who are there have been there a long time or have been there 5, 10 years, 20 years and everybody has staff development people today to make sure that those teachers are updated and are made aware of what is happening in that particular field.

We were fortunate enough to negotiate in our contract last summer on the secondary level that beyond instructional two certifications which would be permanent certification in the State of Pennsylvania we negotiated a mandatory 8 credits every 5 years for teachers.

Now, we are going to pay for a great percentage of that, but it is a means of getting peole back into classrooms after they have not been into classrooms for a long period.

Ms. BACH. Thank you, Mr. Chairman.

Mr. WALGREN. Thank you very much on behalf of the committee for giving us your time and participating with us. We hope that this gives us some contact point with you that we might develop in the future as this issue develops and I hope that our going overtime has not prevented you from meeting any other commitments that you might have had.

So, thank you very much.

We will recess for a half an hour and start again at 1:30 to sphyon through a whole other series of witnesses.

So thank you all very much.

[Whereupon, the subcommittee recessed at 1:05 p.m. to reconvene at 1:35 p.m. the same day.]

Mr. WALGREN. Let me get us going, and I apologize. We just always seem to be late, and I know that you all have time constraints and we anticipated getting started before this.

This morning we heard from a series of witnesses who were elementary math and science teachers, and then high school teachers, and then a panel of school administrators and school board members exploring in general the problems of science and math education and how we can do better in that area.

This afternoon we have perspectives from industry representatives, a community college, and also from the Learning Research and Development Center at the University of Pittsburgh. I do ap-

preciate very much your joining in this kind of a formal but yet unstructured conversation.

This committee has jurisdiction over the National Science Foundation, as many of you know, and does talk to them very closely about their programs and how their programs are serving the needs which we can pick up from the community.

And so our record here and our conversations will give us threads that we can work with that organization, along with the general input to the House of Representatives through the committee process and the work that the staff will give to the record we develop.

I know oftentimes we can't create the wisdom of the world in one short presentation, but it does give us a contact point with which to work and hopefully bend to the national influence in ths right direction.

So let me call the first panel. We have sort of arbitrarily broken this up this afternoon into two panels.

David Bergholz, of the Allegheny Conference on Community Development; James Colker, of the Contraves-Georz Corp.; Milton Gottlieb, of the Westinghouse Research and Development Center, and Dan Swickline, Communications Workers of America Local 2591.

Come on up to the table here, folks, and let's just go in the order that I just called.

I understand that we do have testimony from everybody. Written statements will be made a part of the record automatically, and fuller submissions, if an idea strikes you that you would like to develop, please feel free to do so, and we will incorporate that in the written transcript of the hearing for the review of the staff and the other members of the committee.

For oral testimony I would just love to give you a chance to talk about some of the things that you feel might be most important or ideas that you would like to highlight, and so you may either read or summarize in any way that you feel is most effective to create a focused statement at that point.

So let's start with Mr. Bergholz, from the Allegheny Conference on Community Development.

Mr. Bergholz, welcome.

STATEMENTS OF DAVID BERGHOLZ, ASSISTANT EXECUTIVE DIRECTOR, ALLEGHENY CONFERENCE ON COMMUNITY DEVELOPMENT, PRESIDENT, PUBLIC EDUCATION FUND; JAMES COLKER, PRESIDENT, CONTRAVES GOERZ CORP.; MILTON GOTTLIEB, WESTINGHOUSE RESEARCH AND DEVELOPMENT CENTER; AND DAN SWICKLINE, COMMUNICATIONS WORKERS OF AMERICA, LOCAL 2591

Mr. BERGHOLZ. Thank you very much and thank you for the invitation to be here.

I suppose, in looking down the list of people who have been invited to testify, that I represent not only the corporate community directly, through the Allegheny Conference, but also the lay community in terms of detailed knowledge about science education.

I suppose the things that qualify me to testify are having had a good science education at an elementary school in Chicago, and a decent one here in a Pittsburgh area in high school, I also have several children who are actively involved in science programs today in the Pittsburgh public schools.

One of the things that your request caused me to do was to read a report that I had sitting on my desk for a long time, one I am sure you are familiar with, "Educating Americans for the 21st Century," and I was struck in reading it, that this is a document of excellence and that in terms of a national perspective seems to spell out a number of ways for improving science and math education that should be considered.

I was also struck by a couple of major points made in the report. One, the call for "leadership" and, second, that there are costs to making science education improvements and that those costs need to be borne on a variety of levels of both Government and the private sector.

In looking at that document and a number of others, and out of my own experience not only wearing a hat as assistant executive director of the Allegheny Conference but a new one as the president of an organization called the Public Education Fund, there are a number of things that come to mind in terms of improvement of science education and math and technology education in the public schools.

I think that at the Federal level there continues to be a responsibility and that that responsibility ought to be in the areas of creating better teaching materials for science and math educators, the possible provision of scholarship money for those young people who want to go into the teaching profession, and particularly those who want to teach math and science, and the funding of inservice and summer training programs that would most likely be organized at the State and local levels.

Those programs could also be significantly enhanced by private sector interests, both in terms of financing and organization.

I think at the State level we have a flurry of activity. At last count there were 118 State commissions looking into the future of education in our 50 States, four in Idaho, which I thought was interesting that that State would generate four, but clearly they are about the business of looking at graduation requirements, teacher training requirements and a number of issues around testing and standards. This is an important activity and one that ought to focus on the creation of those kinds of requirements that can provide a more organized and continuous experience for both elementary and high school students.

I have been struck in my experience with my children that often the science curriculum in the elementary schools does not seem to relate to that in middle schools and into the high schools, and I think part of the State responsibility might be to help the local community organize total curriculum in a more effective way.

I think the other issue that has come up a number of times in my own experience here with the Allegheny Conference Education Fund, and also nationally, is that although teachers are required to participate in some level of on-the-job training in terms of internships that once they are thrown into that first job they are, to a

considerable degree, left alone, and that the isolation of teachers, from each other particularly in a high school, is extreme. I think the extension of the on-the-job support that might help a teacher develop good teaching habits as they begin their careers is something that ought to be encouraged at the State level, and financially supported at the local level.

I think the whole issue of improving teacher training in local colleges and universities, deserves high priority attention. There needs to be more emphasis on content to go along with the basic pedagogical training, I think is an area of concern and one that we ought to be addressing with some State as well as possibly some Federal leadership.

The other place where I think the State can be helpful, is in the area of computer technology. There are a awful lot of places in this country where the private sector is rushing in to be of assistance and sometimes in a not necessarily beneficial manner.

Just a classic example. I was in school one recently where private sector interests had provided a considerable amount of hardware to assist computer education and left the schools with a dilemma of trying to figure out how to equip the building with an air-conditioned space so as not to have the equipment damaged, when it gets overheated, I think there is a tendency to rush to the assistance of some local school districts without thinking through how one, in fact, is going to incorporate both hardware and software.

I think the States role goes again to certification of teachers, and in math and science that is an area of concern across the country and one that we ought to look at in terms of the development of rigorous and equitable certification standards.

At the local level, where I think most of the significant activity takes place, because I am convinced out of my own experience that educational change happens school by school. When one is confronted with 16,000 school districts, give or take a few in this country, the task appears to be overwhelming. A wide range of initiatives needs to be developed to assist in improving math and science education as well as education in all the disciplines.

Here, locally, one example that is just beginning that is worth watching is one being carried out by the Pittsburgh Board of Public Education, under the leadership of our Superintendent Richard Wallace. This is the Schenley Teacher Training Center Program.

It is a program in which all of the high school teachers, not just math and science teachers, but all secondary education teachers, will be pulled out of their schools over a course of 4 years to come into Schenley for an 8-week training, and revitalization program.

They will be replaced by substitute teachers in the local schools. I think it is a program worth watching. In many urban school districts across the country, where the population of children has shrunk over the last 20 years and where the teaching force is aging because of seniority retraining is a major issue, not just for science and math teachers but for all teachers.

One of the programs that we have instituted through the Allegheny Conference Education Fund is a model that can be beneficial, and it can be beneficial at a relatively small cost. We carry out a program of providing grants to teachers, small grants for in-

novative classroom projects. Many of those classroom projects have been proposed to us by science and math teachers. Some of them have been projects that just impact on a single classroom and a single group of students.

Some of them have been the kinds of projects that have now been established across the curriculum in the District. One comes to mind immediately. The joint project of a math and art teacher. A math teacher was having difficulty getting geometric concepts across to a group of young people. The two teachers got together and developed an arts-related geometry program at the cost of a couple of hundred dollars, granted out of the small grants committee.

That effort is now incorporated across the high school curriculum and, I think, is an effective small program.

I think the other issue at the local level that I would like to explore with you for just for a few minutes is the issue of how to appropriately and imaginatively involve the local civic and business sectors in the improvement of math and science education and public education in general.

Six years ago the Allegheny Conference became involved with the public school system and, as you know, the conference is a 40-year-old civil organization of the city's top corporate leadership that has been primarily interested in the future of the economic development of the region as well as a downtown improvement.

We started with the program of support of public information for the school system, because I am convinced that as much as we talk about our concerns with particular curriculum areas or with particular issues related to school improvement, the one thing that we have a tendency to avoid is a basic concern about how we develop a constituency that is interested in supporting public schools.

I don't mean just dollar support. I mean general support. It should be noted in a city like Pittsburgh with only 14 percent of the households having kids in the public school system, when you go out to seek support for school board members who want to increase taxes to carry out programs and try new initiatives, the basis of that support is relatively small.

We started from the assumption that we needed to involve the business and civic community in a substantial way and that they had to begin to understand the issues that related to school improvement and that they had to be brought to the table in a way that would involve them over the long haul because, clearly, there are no quick fixes with regard to the kinds of problems that we have in the schools, whether it be around math and science education or in any other area.

The Allegheny Conference Education Fund is essentially a fund inside the books of the conference and it provides a relatively small amount of private money, but a significant amount if we think that very little goes to public schools. About $100,000 a year that supports a number of initiatives, including the small grants for teacher programs and the usual adopt-a-school kind of effort that you see around the country. A program of community education where we bring in national speakers on a regular basis to kind of raise the sights of the local civic foundation and corporate community, as well as educational community about issues of the day impact-

ing on public schools, and science education has been one of those issues under discussion, as well as a major concern about how we better relate colleges and universities to carry out programs jointly with school systems that lead to improvement, and, finally, some fairly significant public information efforts.

One thing I think we find all across the country is that school systems do a lousy job of telling their story to the rest of the world, and whoever convinced school administrators a long time ago that mimeographing things on pale pink, blue, or yellow paper was a public information campaign should probably be locked up.

We attempt to come up with materials that get the word out and get widely disseminated so we are not just talking to parents and students but the general community about the future of the school system.

I was struck in December when I got on a U.S. Air airplane that the cover story of the airline magazine was on Pittsburgh, and it was the usual frothy, city of the month kind of report, but one of the things that was covered in great detail was improvements in the school district.

I think it is clear that there are very few cities in this country that are being promoted, for the quality of their public school system. I think part of that has come out of development of an interest on the part of the broad Pittsburgh community in the future of the public schools. The one thing we have accomplished, I think, over the last 6 years, is to put public schools on the town agenda.

What we see through the public education fund, which is a new endeavor that has come out of the activities of the Allegheny Conference Education Fund and which is separate, but it has a 5-year charge of trying to create similar kinds of brokering mechanisms between school systems and the outside community in 40 or 50 cities across the country.

We have accomplished that task that in eight cities—and we will be doing that in another four in March 1984—is that math science technology training is of interest in every community we have visited and that there are a lot of imaginative endeavors being carried out with the assistance of relatively small amounts of private resources. Teacher inservice training, adopt school programs that begin to familiarize teachers with new technology and new training methods, the PREP effort to provide minority students with an opportunity to familiarize themselves with potential careers in engineering, and others that are mentioned in my written testimony.

In terms of looking at future employment requirements in this part of the world, that picture remains somewhat unclear. And though I am impressed by some efforts to codify what is going to be happening in terms of the need for technically trained people in this country, I must admit some pessimism about ability to do that in a way that is quickly helpful.

I am struck by meetings with corporate leaders across the country that there is a changing interest in what is required from the educational system. Six years ago when we began our conversations here in Pittsburgh I came away with the strong impression that corporate leadership was primarly interested in people that read, write, and work on time.

You have a lot more talk today about the educated individual, about the notion that critical thinking, an ability to understand, at least in a preliminary way, basic technology, an ability to think about the fact that there may be a number of careers that one goes through as one progresses through life rather than a single one, and the whole learning to learn set of issues seems to be much higher on the corporate agenda than the previous one of having a technically skilled person come to them for a particular technical job.

I find that personally encouraging, and I think it argues for providing science, math, and technology education to the broadest constituency of young people we can in this country effectively, which means that we cannot ignore women, minorities, and the gifted and others who have special needs.

I think we are at a moment in time, a small crest of a wave out there, where there is a willingness on the part of that corporate sector to get productively involved. I think they need direction from everybody involved, and the issue of how to appropriately involve them without driving them away from the table in terms of asking them for too much or for the wrong things remains an issue that should be continuously discussed.

Thank you.

[The statement of Mr. Bergholz follows:]

Testimony of David Berghols
Assistant Executive Director - Allegheny Conference on Community Development
President - Public Education Fund
before the Committee on Science and Technology-U.S. House of Representatives
Pittsburgh, Pennsylvania

February 10, 1984

In preparing these brief comments I took the time the other evening to reread Educating Americans for the 21st Century, the report of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology. It is a document difficult to improve upon. It provides reasoned recommendations and a set of guidelines for the improvement of math, science and technology education for the children of this nation. Especially compelling to me is the report's call for leadership and commitment at all levels of both the public and private sectors. The report is also clear in its recognition that all that is recommended cannot be accomplished without cost.

In an article appearing in the January 31 edition of the New York Times, Fred Hechinger describes a meeting of 20 experts who were brought together by the Exxon Education Foundation "to define what ails science teaching." He summed up the three days of meetings by stating that "the experts had little trouble diagnosing the disease. They agreed on a number of prescriptions, but they were at a loss in describing how to administer the medicine." Making change in the education systems of this nation is not an easy matter. The current somewhat frenzied activity around testing and standards reform at the state level is generally helpful, but real change leading toward educational improvement takes place in the approximately 16,000 school districts of this nation and most importantly on a school-by-school basis.

We meet here today in an area of Pittsburgh that is a vital part of this city's second renaissance. Yet, not far away, in the Monongahella Valley, we are witnessing an economic disaster of staggering proportion. Industrial cities and towns in the Mon Valley are facing the collapse of their employment, governmental and educational infrastructures. There can be no more graphic demonstration, from my point of view, for the need for improvement in math, science and technology education for our young people than the one that is indicated by the dislocation that is occurring on our doorstep. And I say this not only in terms of what it implies in describing what the future job market will be, but also in terms of the general need for a broadly educated citizenry that can comprehend and then address the range of problems of similar dimension that will face this society in the future.

The requirements of the local job market are unclear. Technological change as well as the restructuring of this nation's manufacturing base (now occurring in the arena of high technology as well as with our smokestack industries) is happening so quickly that it is difficult to develop effective methods for determining the day to day, let alone the long term, needs for specially trained personnel.

It can be argued, however, that the need for a citizenry that has basic skills in scientific inquiry, technology and critical thinking will be vital to this nation's ability not only to compete in world markets, but in the preservation of our way of life. It also should be stated that the current pressing concern with math/science and technology education must not overshadow the need for sustained public and private sector interest in all areas of educational need: the arts, humanities, language and citizenship among others.

From my perspective, there are some rather simple actions that can be taken by both the public and private sectors that could assist in the improvement of math, science and technology education as well as other disciplines. They are:

at the federal level...
- assistance in the creation of better teaching materials.
- the provision of scholarship monies for promising math/science students who want to enter the teaching profession.
- funding for inservice and summer training programs to be organized at the state and local level.

at the state level...
- the adoption of math/science requirements that provide a more organized and continuous experience for both the elementary and high school student.
- funds to allow for the development of "on the job" support programs for entry level teachers.
- leadership in strengthening teacher education programs in colleges and universities.
- the promulgation of appropriate computer and information technologies.
- the adoption of rigorous and equitable teacher certification standards.

at the local level...
- the establishment of teacher retraining opportunities (the Schenley Teacher Center, a Pittsburgh Public School initiated effort, to provide this kind of service for all secondary teachers, over the next four years, is in its first year of operation).
- incentive programs that allow teachers to develop and carry out special classroom projects.
- involvement with the local, civic and business sectors towards an agreed upon program of supportive initiatives.

The successful experience of the Allegheny Conference on Community Development in Pittsburgh is one model of the kind of public/private involvement mentioned above.

The Allegheny Conference's Education Fund,* organized six years ago, has solicited private sector assistance to carry out a series of efforts in support of the Pittsburgh Public Schools. These efforts include a program of small grants for teachers that has provided special resources for math and science educators as well as others in the school system. A local Partnerships in Education program links 19 businesses, corporations and nonprofit organizations to middle and high schools for wide ranging programs that in many instances focus on math, science and technology. Rockwell International, Alcoa, Westinghouse Electric Corporation, PPG Industries are all Partners and bring their considerable technical resources to these relationships.

The Pre-Engineering Program (PREP) financed by local contributions provides academic support and summer school opportunities for minority students interested in engineering careers. A new program carried out by Conservation Consultants develops summer intern opportunities for math and science teachers with local industries. Privately financed, the program allows teachers to update their skills and become more familiar with corporate needs and requirements. Two years ago the Pittsburgh private sector helped to initiate the Governor's School for the Sciences summer program for gifted Pennsylvania students located at Carnegie-Mellon University.

Though these efforts are small in scale, they are relatively inexpensive, bring new constituencies of interest to the issue of public school improvement and develop programs that school systems would find impossible to finance and administer on their own.

The success of our efforts in Pittsburgh has led to the development of a new national organization, the Public Education Fund,* Financed by the Richard King Mellon and Ford Foundations, its five year mission is to assist in the establishment of more than 40 organizations similar to the Allegheny Conference Education Fund in urban communities across the nation.

In carrying out this task in cities such as Los Angeles and San Francisco, California; Decatur, Illinois; Wilmington, Delaware; Tucson, Arizona; and Paterson, New Jersey, we have found interest in the improvement of math/science education for all young people to be an item of the highest priority. However, it should be noted that math/science initiatives are but a part of a broader community agenda to improve public education in all its aspects and foster effective and appropriate public/private relationships.

For instance, the first program of the newly-financed Los Angeles Educational Partnership is a math/science teacher retraining effort that will send fifty "master" teachers back into the schools to train their peers. A generous grant from the Atlantic Richfield Corporation has initiated this endeavor. The Los Angeles program also will include small grants for teachers and a public information effort to improve the image of the schools in the community.

*(Attached are a number of documents that describe the activities of the Allegheny Conference Education Fund and the Public Education Fund.)

The GTE Corporation of Stanford, Connecticut recently announced a $750,000 fellowship program that will enable practicing mathematics and science teachers to study their fields indepth and use their study in classroom projects. The program will be operated in several states where school officials have demonstrated a commitment to improving public schools. Teachers will be given $2,500 grants for study or inservice training followed by an additional $2,500 to develop plans for taking what they have learned into the classroom.

In closing, it has been my experience both in Pittsburgh and on the national level that the business and corporate community has a developing interest in participating in the improvement of elementary and secondary education. It is also my experience that this is an interest that is not just focused on reading, writing, arithematic and getting to work on time. It is a concern about the development of the fully educated individual, a person who can achieve their potential in the workplace as well as in the life of the nation. It is also a concern with a future that will require our children to live in a world that will change even faster than the one we know. I think that corporate and civic America recognizes this challenge and is prepared to participate in meeting it.

Thank you for the opportunity to present these remarks to the Committee.

Mr. WALGREN. Thank you very much, Mr. Bergholz. That is an interesting testimony. We will come back to it, and let's go on down the list then to Mr. Colker.

Mr. COLKER. Thank you.

First, my own education was obtained in Pittsburgh entirely. I went to the public school here and I have gone to the University here. I have children who were also trained in our primary and secondary schools and my wife is a primary school teacher.

My own experience in hiring technically trained people for the past 30 years is the experience that you have in a small company that is in very advanced technical areas. Our company designs and manufactures products that are used primarily in the aerospace and automation fields, and we employ a very wide variety of technically trained people, from semiskilled people to do assembly work to very highly skilled engineers and scientists.

We have found that for most of our employees we must provide specialized training; therefore we have internal programs that train our semiskilled people and the people in higher skill categories. We generally obtain personnel from technical schools and universities, but even at that level we expect to provide a considerable amount of training.

We provide training courses within the company and send our employees to universities or technical schools for further training.

Our current and future personnel needs require that we have people with very good basic communications skills and reasoning abilities and the capability of working more or less independently in a fairly exact way.

We require these skills because the future direction of the work in our industry is that of an intellectual rather than a manual nature. We put very, very high emphasis on reasoning and ability to follow directions and we believe this emphasis will become even more pronounced in the future.

We also find that supervision of our workers is an extremely complex job that I think will also grow to be much more complex.

The skill requirements that we expect the schools to provide are very, very basic. At our lowest skill level, this would be the type of person we train for assembly. For skilled jobs, a high school education is required, and our emphasis is on the ability to read and understand what is read. Again we place a high emphasis on understanding.

This skill is very, very important. It becomes even more important as computers are taking over a greater part of the work that is being done in our company. We expect to train our workers in the specific skills that we require. If such a worker has the ability to speak well and to express his thoughts logically in writing, then this worker can advance to higher level jobs of a clerical or supervisory nature.

For the next job level, where we train the worker to a higher skill level than that required for an assembly job, a good accurate knowledge of arithmetic is necessary. Here, we mean addition, subtraction, multiplication, long division, fractions, and decimals, just the real basic things that many of us just don't learn.

For yet a more advanced level job, we would require algebra and most important trigonometry, and for the most advanced at a non-university level job we would expect some knowledge of differential and integral calculus. A knowledge of science, particularly physics with emphasis on laboratory experience, is also very helpful to us but not necessary.

If the basic mathematical understanding exists, we can train the worker for a higher skill level job.

All the skills that we require are taught in the local areas of primary and secondary schools and, again, we would like to emphasize that basic skills are the essential thing we look for. We know the application of those skills is going to change very much in the environment of the future and we are prepared to train our people to cope with the needs of the future.

We also utilize people who are trained in the conventional machine shop skills. We operate a machine shop. Again, mathematics is required and some machine shop and more important, drafting courses in high school or technical school are helpful but again not necessary, because we operate a full machinist apprenticeship program.

We also train workers in the grinding and polishing of optics. Here, advanced mathematic skills through trigonometry are necessary, and again the training for the specific job is supplied by us through an apprenticeship program. We do hire draftsmen and electronic technicians who have been trained in technical schools in the area. Consequently, with our evaluation of the requirements for high school graduates, we regard reading, writing, and mathematical ability as primary skills and drawing and electronic theory as the secondary skills required.

The electronic courses should be supported by laboratory work and, again we like the technical schools to concentrate on basic education. We will provide the training necessary for the employee to function in the environment of our company.

Summarizing our skill requirements, reading and understanding what is read is necessary for all the jobs in our company. Supervisors must be able to express themselves clearly and in writing. High school level mathematics is required for all higher skilled jobs. The study of science and some technical school training is useful. With this foundation, the company is prepared to train workers.

The company interface with the secondary schools and the universities in this area is primarily that of recruiting university graduates. The company also becomes involved with the students before graduation through its summer jobs program and the participation of some of the senior company personnel as advisers to the universities or teachers of courses.

The company also uses the area's technical schools and universities for the continuing education of its employees.

The company's position with respect to education is that the curriculum offered by most high schools, technical schools and universities in this area is satisfactory for our purposes now and in the future. However, we believe that more care must be exercised to ensure that the students truly master the course material. We believe that greater attention should be paid to basic education and less to the development of specific skills which are going to become obsolete quickly in any case.

We are prepared to train the employees if they have the basic background in the skills that are necessary in our company.

Thank you.

[The prepared statement of Mr. Colker follows:]

TESTIMONY FOR THE COMMITTEE ON SCIENCE AND TECHNOLOGY

U. S. HOUSE OF REPRESENTATIVES

BY

JAMES COLKER

PRESIDENT, CONTRAVES GOERZ CORPORATION

I am James Colker, President of the Contraves Goerz Corporation, located in Pittsburgh, Pennsylvania and Charlotte, North Carolina. This company is engaged in designing and manufacturing products of an advanced technological nature used in the aerospace and automation markets. We employ a wide variety of technically trained personnel who range from semi-skilled electronic assembiers to highly skilled engineers and scientists. We have internal programs to completely train semi-skilled personnel but must obtain personnel in the higher skill categories from technical schools and universities. Even at the higher skill levels, we provide some training courses within the company as well as sending these employees to universities and technical schools for further training. Our current and future personnel needs require people with good basic communication skills and reasoning ability and the capability of completing work assignments in an exact way without a large amount of supervision. We require this because the future direction of work in our industry is that of an intellectual rather than a manual nature. Reasoning and the ability to follow directions exactly will become even more important in the future than they are today. Supervision of workers will also grow more complex.

The skill requirements for our workers are very basic. For our lowest skill levels, we require a high school education with emphasis on the ability to read and understand what is read. We expect to train this worker in the specific skills we require. If such a worker has the ability to speak well and to express his thoughts logically in writing, advancement to higher levels jobs of a clerical and supervisory nature is possible. For the next higher job level, a good accurate working knowledge of arithmetic is required. This must include addition, subtraction, multiplication, long division, fractions and decimals. For yet a more advanced level job, we would require algebra and trigonometry and, for the most advanced level for a non-university graduate, we require some knowledge of differential and integral calculus. A knowledge of science, particularly physics with laboratory experience, is helpful but not necessary. If the basic mathematical understanding exists, the worker can be trained by us. All of these skills are presently taught at the area primary and secondary schools.

We also utilize persons trained in the conventional machine shop skills. Again, mathematics is required and some machine shop and, more important, drafting courses in high school or technical school would be helpful but not necessary as we operate a machinist apprenticeship training program. We also train workers in the grinding and polishing of optics. Here, the advanced mathematical skills through trigonometry are necessary and, again, worker training is provided by our company.

We do hire draftsmen and electronic technicians who have been trained at technical schools. Consistent with our evaluation of high school graduates, we regard reading, writing and mathematical ability as primary, and drawing and electronic theory as secondary skills. The electronic courses must be supported by laboratory work. We

like the technical schools to concentrate on basic education and we expect to provide the training necessary to function in our company.

Summarizing our skill requirements, reading and understanding what is read is necessary for all jobs. Supervisors must be able to express themselves clearly and in writing. High school level mathematics is required for all higher level skilled jobs. The study of science and some technical school training is useful. With this foundation, the company is prepared to train workers.

The company interface with secondary schools and universities is primarily that of recruiting university graduates. The company also becomes involved with the students before graduation through its summer jobs program and the participation of some of the senior company personnel as advisors to the universities or as teachers of courses. The company also uses the area's technical schools and universities for the continuing education of its employees.

The company's position with respect to education is that the curriculum offered by most high schools, technical schools and universities in the area is satisfactory for our purpose now and in the future; however, we believe that more care must be exercised to insure that the students truly master the course material. We believe that greater attention should be paid to basic education and less to the development of specific skills that, because of rapid technical growth, soon become obsolete. We are prepared to train the employee in the skills necessary to work in our company.

Mr. WALGREN. Thank you very much, Mr. Colker. That is a particularly interesting perspective, coming from a company that is so specifically focused in the highest of technology areas, and yet loud and clear comes through the need for good basic skills and ability to be trained at a later time. That isn't quite the perspective we get from many people who want the work force to spring to full bloom from the schools themselves.

Mr. COLKER. In our industry that just doesn't happen.

Mr. WALGREN. Dr. Gottlieb, you may proceed.

Mr. GOTTLIEB. Thank you very much for the opportunity to be here and to offer my opinions.

I would like to say at the outset that I am not an expert on education but I do have some perspectives and some opinions that I think might be useful, and I would like to say that my perspectives have been formed by my having been at the Westinghouse Research and Development Center for some 25 years now.

As such, I have had an opportunity to have a fairly good view of the overall technical activities of the corporation and also to come in contact with a large number of technical people, both older ones who have been trained some time ago and also very recent graduates who have joined us.

Another activity that I am involved in is with the Westinghouse Science Honors Institute. This is a local program that we at the R&D center operate for high school seniors in Allegheny County. This program consists of a series of lectures that are given between October and March on Saturday mornings.

The lectures are given primarily by scientists from the research and development center but we also have a few speakers from Carnegie-Mellon and the University of Pittsburgh, and they include demonstrations and question and answer periods.

Overall it is a very, very successful program with relatively good participation from the high schools in this area.

The good news that I would like to break that I have seen from this program is that of the roughly 250 to 300 students that we see each year that are selected on the basis of applications that call for SAT scores, a brief essay that the students write, grade point averages, recommendations, I can say with great pleasure that the very best of the students we see in the high schools today are just as good as they ever have been. There has been no deterioration in the quality of the very best of the students.

The negative side, I have to say that we send out applications to approximately 100 high schools in this area, and we get a response from about 60 percent of those high schools. Apparently some 40 percent don't even see fit to respond to this program, which is a very excellent one with very good recognition, which is absolutely free, for nothing, and yet only 40 percent of the schools won't even take the trouble to respond.

I think this is representative of an attitudinal problem which, in my opinion, is fundamental to a lot of the problems that we see in science and math education.

Let me turn now to what I think I believe to be the needs of the work force within a corporation like Westinghouse. First of all, I think it is obvious certainly to everybody in our corporation and I think to anybody who has closely watched the corporation in

recent years, that we are undergoing dramatic changes in the character of our industry.

We are moving away with startling speed from conventional manufacturing and going more and more into the new technologies. If that needs to be underscored for people in the western Pennsylvania area, only within the past few weeks hundreds of jobs have been terminated in the Westinghouse Switch Gear Division. This is merely symptomatic of the movement away from conventional manufacturing.

Now, fortunately for the corporation, new activities are arising very rapidly in other areas, but the skills of the people who will be involved in these new areas unfortunately do not coincide with the people who are being laid off from the manufacturing areas of the country.

The new thrust of corporations like Westinghouse will involve a hierarchy of people with skills in science and technology at the highest levels. There will, of course, be Ph.D. level scientists, engineers, those people will be very highly trained. They will have postgraduate education in their particular disciplines, but I would like to emphasize that lower down on the hierarchy of technically involved people there will be managers, technicians, information specialists, accountants, purchasing agents, sales people, whatever.

All of those people will be required to have at least some level of literacy in technical areas, in science, in mathematics.

Now, the levels of ability that will be required for those different positions will, of course, vary dramatically. Obviously, one does not expect the same sort of educational background from all of these people, but I do wish to emphasize that on one or another level some degree of technical literacy most certainly will be required.

Now, having said that, you might expect me to make a plea for even more involvement of science and math in the public school educational curriculum. Let me say why I don't believe that to be the highest priority.

I can make some personal observations from the contacts that I have had with newly hired engineers into the corporation who are at the relatively high level of skills in the technical professions already. They have been well trained in their professions.

In my role in the Westinghouse Science Honors Institute I see certainly the very best of the high school students in this area, and yet my observations are this, primarily, that their communication skills are poor. Those are the very best people that I see in our educational system and yet my overall observation is that their communication skills, their writing ability, their speaking ability, the ease with which they can express themselves not only in technical ideas but in other ideas as well, is poor.

I see a large amount of written documents that these people generate and the writing skills are at an abysmally poor level. Now something is very, very wrong with the system that is producing this level of ability in the communications skills.

If I were to make up a list of priorities that I would like to see in the educational system to fill the needs of our industry in the future, I would say first and foremost what we require is, I would like to say a return. I can't really document that this is so, but I would like to see a movement toward rigorous academic discipline

not only in math and science, but in every course of study that is given in the public school system.

I think what needs to be developed is respect for and the habit of rigorous thought. Now, I have two children who have gone through the educational system. One is in the middle school now. One is a senior in physics at the university level who wants to major in physics in graduate school.

They have had good science backgrounds, but my personal observation from what they have been through in the public school system is that the academic rigor is lacking terribly in, I would say, most of the other courses of study that they have been exposed to.

I think that the writing skills need to be seriously addressed, not only in English. I think that writing as a skill should be taken seriously in every course of study. If you look at what is required now by way of evaluation for science course, for example, and many other courses as well, it is not written composition. It tends to be multiple guess types of examinations.

Well, there are reasons for that, economy of time. It certainly makes it easier for the teacher. It does nothing to develop the writing skills of the students.

Now, why are writing skills so important? I believe that they are so important because good writing requires clarity of thought. It requires analytical skills. Those are the tools that will not become obsolete no matter what the future holds for us in industry.

Finally, on my list of priorities, as has been very well documented in these hearings already, is the need for math, science, computer courses at all levels of ability. I think that we are fooling ourselves if we believe that science can be presented on anything other than an elitist basis.

Science has always been an elitist enterprise. I think that the very best of our science students must be exposed to a level of course work that will be unattainable for the large majority of students in the public school system.

On the other hand, there should be course work tailored to every ability level science we would hope to provide employment in our economic system for people at all ability levels.

Now, again, what I would like to emphasize is that the academic training that is required in all courses, which rigor and analytical thinking is held in high esteem, I think that those skills will be transferable even to highly technical professions.

For example, I can tell you that in one of our Westinghouse divisions that deals with computer aided design and computer aided manufacturing, which is primarily using occupations in computer programming, a great deal of programmatic time is required to develop those.

The people involved in developing those programs are by no means all graduates of engineering schools or technical professions. Many of them in school majored in English and languages or whatever. They are, without doubt, very intelligent, capable people by virtue of the course work that they have had in their educational backgrounds in things like English or whatever.

They have developed the tools; namely; clear thinking, clarity of expression. Those are the basic tools for good computer program-

ming, not a course in basic or algorithms which may be obsolete in the future anyway.

Finally, I would like to make a few comments on what I think it is that industry might do to help fill the gap in science and math education.

I would like to say that there are tremendous resources available in industry, especially in industries like Westinghouse, which has a very, very large number of technically trained people. This is a treasure house of educational resources that is only being barely scratched.

The Westinghouse Science Honors Institute is merely one example of how those resources can be used. As is presently constituted it is available only in Allegheny County. It is available to about 100 schools. Eventually, each year only about 250 or 300 students end up participating. It is a high level elite type of activity.

Nevertheless, there are other industries in the Allegheny County area that do have similar resources that I think would be more than happy to assist with programs of that nature.

I think that programs like that not only could be extended to include a great number of students, I think that they could be extended to be offered to teachers as well.

Let me say, though, on a negative side of that, that our lectures are open to the high school teaching faculties as well as the students. We do invite them. I would be embarrassed to tell you the low numbers of teachers that will ever show up at these. Again, an attitudinal problem.

I think another measure that could be taken for industry to help in the education of science and mathematics is to use not only current industry personnel but retired people as well. There are huge numbers of engineering, science and mathematically trained people in industry who are retiring every year that I know would be delighted to participate in some way in secondary school education.

I get asked this, the possibilities about this being available to them any number of times by my retiring colleagues at the R&D Center. Yet, as things are presently constituted, there is no mechanism for taking advantage of the willingness of these people who are not only technically trained but who also have the advantages of age, wisdom and experience that they could somehow bring with them and give to the students.

In addition to programs like that, I think that it would be possible for current technical employees to be available for teaching for a day, for a week, for a month, for a semester, whatever, in the public school system. There are many people who would be, although they have no formal college training in secondary school education, they have within them the skills that are required for teaching.

I really don't think that they need any formal training in teaching per se.

Now, we have done one here, there are programs like that of one of our people from the R&D Center going to a local school system for an extended period of time, and I must tell you, they have not been entirely welcome. Again, an attitudinal problem. They tend to be resented by teachers, faculty, whatever.

I think that there may be a problem in that industry people like that may develop a sense of, shall I say, insecurity in public school personnel. It's an attitudinal problem. There surely must be some way of overcoming that.

Finally, I would like to emphasize again this attitudinal problem. Another program that Westinghouse has been running for 43 years is the Science Talent Search. This is a highly prestigious program that operates on a national scale to identify exceptionally talented high school seniors in science and math.

To give you an idea of how elitist this program is, 54 alumni of the Westinghouse Science Talent Search are Nobel Laureates. This is a highly prestigious program.

Each year 40 high school graduates are identified as finalists in this and then 10 are winners of rather nice scholarships. In all of the 43 years that this program has been operating there has never been a winner from Pennsylvania.

Now, there are many reasons and, mind you, Pennsylvania is the headquarters State of the corporation, and never has there been a winner from Pennsylvania.

The winners have been concentrated from schools in the New York area, Bronx High School, Stuyvesant High School, and other geographical areas. These are schools that are devoted to excellence and I think that it is the devotion to excellence that is very largely an attitudinal problem that, in my perception, tends to be lacking in areas like the Pittsburgh area.

From my own personal contacts in connection with the Westinghouse Science Talent Search and making it more available to students in the Pittsburgh area, I have more often than I would care to say encountered a certain degree of hostility from high school teachers again who would rather not be threatened by this elitist, excellence-seeking program.

I think that there is a certain degree of comfort that is derived from mediocrity, and this is an attitude that I would like to see dealt with on some level or other.

Thank you very much.

[The prepared statement of Mr. Gottlieb follows:]

SUMMARY OF STATEMENT TO CONGRESSIONAL COMMITTEE ON SCIENCE AND TECHNOLOGY

M. Gottlieb
Westinghouse R&D Center

Industries such as the Westinghouse Electric Corporation I represent on this panel, are in the midst of revolutionary change, in which their ability to thrive, indeed to survive, will depend upon their adapting to a fiercely competitive technological environment. The products of these industries will clearly gravitate more and more towards sophisticated new areas, and away from conventional manufacturing. This shift is creating a need for a work force able to deal with the demands of such new technologies as micro-electronics, robotics, bio-engineering, information processing, etc. This work force may represent all levels of activity, including highly trained PhD scientists, engineers, managers, technicians and sales staff. Our success in the coming decades, and our capability to provide meaningful employment to large numbers of people, requires this work force to be literate in science and mathematics at least to the level at which they must function. It is, therefore, in the interests of industry to promote programs to improve the quality of science and math education; such programs are also a crucial interest of economically depressed areas whose future will depend upon attracting new industries. I wish to address here some particulars of what we perceive as our needs, and some ways in which we can contribute to their fulfillment.

I have stated that we are in the midst of revolutionary change, and it is perhaps just that process, rapid change, that best characterizes our present situation. We are coming to realize that this process will, if anything, accelerate in the future. It is vital for our educational system to prepare students for change, to have the adaptability to cope with new and unfamiliar ideas. Our young people will be poorly served by being narrowly trained for jobs that will be obsolete within a few years. Fortunately, such preparation is consistent with the training required for high achievement in science and math, since the basis for both rests upon a foundation of analytical thinking and academic discipline. I do not mean by this that it is necessary for every student's program to be top

heavy with science and math courses (although a reasonable minimum should be required of all) but that the highest degree of academic discipline should be instilled in all students. This is sadly lacking today in our schools; we find a surfeit of courses with little intellectual content. By contrast, it is well recognized that such rigorous programs as foreign languages have all but disappeared. It might be asked how training in foreign languages, for example, might contibute to a person's employability in later life. I would answer in response that it is well documented that many successful computer programmers were, in fact, non-technical majors; in studying their subjects, they also acquired the ability to think analytically and with clarity, the fundamental tools of good computer programming.

A sadly neglected domain of education, of great importance to a technologically oriented economy in which the creation and transfer of information are basic, are the communication skills, writing and speaking. A marvelous idea is useless unless it can be effectively communicated to others. The usual vehicle for accomplishing this is the written report, and yet my experience with even the relative high achievers among high school (and even college) graduates, suggests an appalling inability to construct a comprehensible English sentence. Why is our own language not being effectively tought in our schools? Even the technically schooled will have diminished value to industry unless they possess at least a minimum of writing ability. Since the only way of learning to write is to write, it is important that our schools require more, that it be critically evaluated, and that the rules of grammar be enforceed.

I wish to emphasize with the examples I have given above that I believe the most basic need of the educational system in serving a future technological society is not to replace the curriculum with ever more science and mathematics, but to demand intellectual discipline of everything that is taught, to instill respect for use of the mind. Unless this is done, great numbers of our young people will be destined to find no meaningful place in our future economy. Having said this to establish what I believe to be basic to our educational needs, I would like to turn to the question of

the science and math curriculum.

The newly evolving high technology industries will be staffed by people whose functions will extend from the highest levels of basic research, for which advanced graduate degrees will be required, to laboratory and workshop technicians whose hands will bring to actual realization the results of that basic research. While the need for a sound high school science and math background may be self evident for a professional scientist, it is also a crucial need for the student whose entry level to work may be much lower, if he is to have the opportunity for meaningful contributions and eventual advancement. Currently, vast numbers of students never take any science or math courses at all, for a variety of reasons. Clearly, it is not feasible to expose students of all abilities to the same science courses, but even those with lower interest and ability should be required to take a well structured course, tailored to their level. The needs of such students can be served by a science and math curriculum which recognizes these differences. This is not to say that a stigma of low intelligence should be attached to a lower tier science course; it may be appropriate for very high ability students whose academic interests lie elsewhere. What is important, however, is that each student may leave high school with at least a minimal appreciation of science. Since every graduate will be a citizen, he will participate in decisions regarding technological and scientific issues, many of which are becoming of paramount importance. For those students who will follow careers in science and engineering, the quality of the offerings is in need of improvement.

The overwhelming bulk of work that companies such as Westinghouse will generate in the future will be engineering oriented. All engineering education today is very highly computer based, even those areas that are not computer directed. Very large numbers of college students are now pursuing engineering courses, and the numbers will probably increase in the future. It is, therefore, important to enhance the computer literacy of our high school students. This is not only important for those who will become engineers, but even those who will become secretaries or librarians. Word processing and information retrieval will fall into their domain as well. Computer literacy

encompasses not only sophisticated programming, but also computer usage. Every high school student should be exposed to at least a minimum level of computer usage (above the level of video games). An occupational hazard engineers have always suffered is technological obsolescence a few years after graduation. With the rapid pace of new development, this obsolescence can proceed with remarkable speed. This is agravated by the high degree of specialization required by the current engineering curriculum. This makes it doubly important for high school students to leave with a sound, general background in science and math so that they will have the tools with which to adapt to new technologies, as the material they may have learned in enginnering school becomes outmoded.

While there are islands of science teaching excellence to be found in the secondary schools, the overall system is in disrepair. The price we pay for this is a loss of talent to society; the tiny minority of highly gifted and motivated students will probably be successful regardless of the quality of their science courses, but those who need the extra push to achieve their full potential are left out. The main ingredient lacking in high quality science teaching is qualified, motivated faculty, and the atmosphere to support it. There is much controversy over the question of how to correct this situation, with no clear resolution on the horizon. There are measures that we in industry can adopt to help, but basic reform will be needed to achieve levels of science and math teaching quality we understand to be carried out in countries such as Japan. We recognize that many foreign educational systems, such as in Japan, are far more elitist and competitive than would be acceptable in the U.S., but the long range health of the U.S. economy may require a greater share of the available resources to be devoted to the development of excellence. The challenge is to do this in a manner that is perceived to be both desirable and equitable. Science and mathematics have always been elitist, and will so continue, making it inevitable that relatively few will participate in advanced offerings with outstanding teachers and facilities.

The demands placed upon the education system to achieve the aims of improved instruction in science and math are enormous, perhaps impossible, but a beginning must be made immediately. There are ways in which industry can help, with programs already in place which could be expanded, and new

programs that could be established. For example, Westinghouse has sponsored the national Science Talent Search for over 35 years, a competition for high school seniors in which 40 winners are named each year, and awarded scholarships. This is a highly prestigious award with wide recognition in the science community. It is, however, exceedingly selective, but very successful in identifying outstanding ability at an early age; five STS alumni have received Nobel prizes. On a more modest level, the R&D Center sponsores the Westinghouse Science Honors Institute, an annual program of Saturday morning lectures given to about 275 high school seniors selected from about 60 Pittsburgh area schools. The lectures are presented by scientists from Westinghouse and from neighboring universities, and are given on a voluntary basis. Westinghouse underwrites the administrative and incidental costs of the Institute. The purpose of these lectures is to expose the students to professional scientists, who are chosen on the basis of their ability to communicate well with students, in order to promote their interest in careers in science and engineering. Other industries with research laboratories have recently begun similar programs, and the response has been good. Still more use could be made of the enormous teaching resources that might be made available from industry. Advanced instruction for high school science teachers could be offered, perhaps coupled with summer internships at research laboratories. Industry scientists and engineers might be loaned to schools for brief, or perhaps extended periods of time to teach advanced courses, or to participate in other ways. An untapped reservoir of potential science teaching talent may be available if a mechanism for allowing retired professionals to teach could be found. There are many such people who would welcome an opportunity of this kind to remain active after retirement.

In summary, our new industries will require personell at every occupational level to be minimally literate in science, math and computer usage. Successful advancement will go to those who have acquired the skills necessary to adapt to rapid technological change; these skills will rest upon a foundation of rigorous, analytical thinking, qualities that must be applied to the entire academic program. Industry has educational resources in science that should be exploited by the school system; a number of programs are already in place, and these should be expanded.

Mr. WALGREN. It's almost enough to make you want to resign from Congress.

We passed a note here that says you have to work on your sons for the Westinghouse science talent. I am beginning to wonder what sort of models or what do we pursue and how do they absorb that, and in many ways the congressional function. You can't quite define it as the pursuit of excellence to put it that way, although perhaps it should be, but that we never had one from Pennsylvania amazes me.

I have been to the function that they have at the end of each year and it never struck me that there was no one from Pennsylvania.

Well, I appreciate very much that testimony and enjoyed it. We will come back to it.

Let's turn to Mr. Swickline.

Welcome, Dan.

Mr. SWICKLINE. Thank you, Chairman Walgren, Ms. Bach, Dr. Brown. I was sort of hoping that your aide, Ms. McCormick would be here. She wouldn't take no for an answer.

I felt at the time when she asked me to come that I wasn't qualified or could add substantially to the information you were receiving, but after listening to those three gentlemen I am convinced of that, but I would still like to sign her up as a steward for my local. She is quite convincing.

A little background on myself. I am the president of CWA Local 2591. I represent five separate contracts. I negotiated primarily Western Electric employees and the shop and warehouse and installation divisions. They since divested and changed their cotitles. I am still not used to that and I will stick to the old, if you don't mind.

I also represent an interconnect company which deals in installations of telephone and telecommunications equipment, an electrical company, an electrical contractor and a construction firm. So I have sort of got a wide range of work groups.

In all of those work groups the basic education requirements are a high school education. The electrical contractor himself, he, at times, has hired employees that have technical training at one of the local technical schools. In the Western Electric groups, as has been the practice in the whole Bell System, which I am familiar with, they like to mold their own employees in their own fashion.

The groups that I presently represent have been reduced so much in size, at one time the Western Electric installation group that I represented was 550 installers. There are presently 96 left. Of the warehouse and shop men of 220 of them I presently have 18 under contract.

In the State with my brother local in Philadelphia, we at one time 10 years ago represented approximately 1,800 employees just in the Bell System alone. We now represent about 330 combined in both locals.

Again, to get back to my background, I have been an officer and a steward for 30 years and a president for 17 years, and I have never seen our industry so distraught. It is not quite chaos but confusion especially because of divestiture.

In particular the installation division, probably the most skilled employees in the Bell System, their skills were acquire through the Western Electric Co., sending individuals to various schools throughout the country.

The types of equipment that they presently install basically don't wear out, and if something does require maintenance a computer tells the maintenance people what has to be replaced. It is not repaired; it is replaced as a unit. This requires even less skill.

At one time, and just 10 or 15 years ago, it used to take my men upward of a year to install a central telephone office. The maximum time today for the latest electronic switching systems equipment is no more than 17 weeks. It depends on the amount of telephone lines that go into that central office, some as little as 6 and 9 weeks they complete central offices.

Competition is eating in, but I have a small interconnect company. The interconnect company itself has changed hands at least a half dozen times in the 10 years I have had them under contract. They are presently owned by a conglomerate.

My own personal opinion is the only reason they bought them is for tax purposes, because that telecommunications market rises and falls so quickly and there is so much competition that they have a hard time keeping their noses, so to speak, above financial water.

In your letter that you sent to me where it says the current and future personnel needs of your company and industry, the group that I am more familiar with is the Western Electric group, they haven't hired since 1970 in Pennsylvania alone. Nationwide in 1970 we had 32,000 employees in the installation division alone. Today we have 11,500 nationwide.

As I told you, in the warehouse and shop in the Pennsylvania Avenue plant there are 18 employees left there out of 220. That building has been sold and I expect the 18 employees to be phased out witin the next few months.

In the interconnect industry, and I am pretty familiar with that, I also had a cable TV under contract until they went bankrupt. There is such a glut of electronic skilled ex-employees, laid-off employees in Pennsylvania and in particular western Pennsylvania that they have very little trouble getting skilled employees.

In particular, the MCI Corp. is picking the cream of the crop of my laid-off Western Electric employees. There is hardly any need to retrain and most of the interconnect companies throughout the country are doing just that.

If a Bell unit has a layoff the interconnects are those people because they are so skilled and have been trained so well.

As far as future hiring in the Western Electric, AT&T technologies group incorporated network systems. I doubt if Western Electric will do any more hiring.

The 11,500 we have nationwide are more than sufficient, and lately we have been negotiating, or I have, lately with management just on bringing in temporary help. They don't want to hire full-time help or even in the category parttime because with part-time help they are required to give fringe benefits.

What they want to hire now is temporary help, hands to do the heavy labor work, which there is not much of, and then terminate

them as quickly as the job is done on a one-job basis. Some of our locals and in particular in the Far West have gone through this progress. They have agreed to hire temporary help for no more than 6 months, and on a job-by-job basis.

The only fringe benefit they are entitled to is a holiday, if a holiday should fall any time during their work period. They start at the minimum and if they should stay long enough to reach 3 months and they would acquire another upgrade in pay, which is only about a dime.

Necessary work skills, as I told you before, and I am familiar with every phase of the telephone industry, I know the local presidents quite well and I know the type of hiring that did occur at one time in the Bell System.

The Bell System likes to train their own regardless of whether it's a Bell lineman or a Western Electric installer or an AT&T craftsperson, they prefer to train their employees in their own mold and at their own schools with hands-on types of training.

As far as the other companies that I represent, the electrical firm I told you about, if he hires, and in this market in Pittsburgh he has no trouble hiring electricians that have been laid off in the mills and factories with lots of service and a lot of electrical skills, so he's got a free market, an open market to pick out the best.

I just recently negotiated a contract with him and his major demand was to reduce the starting rate so that he could hire these people at a lower rate than I normally had written into the contract.

Interface. As far as the Western Electric Co., they never did associate in any way with the local schools. Unfortunately, it probably would have helped the company more than the schools. Bell, I am not that familiar with them approaching local schools. I know that both Bell and Western Electric do have a national scholarship and unlike this gentleman there was one local resident, one time in all the 30-some years that I have been associated with Western Electric, that has won the scholarship.

I hate to be so depressing. That was one of the reasons why I didn't think I should be here, but it's the truth in our industry, the electronics industry especially in telephone and telecommunciations.

We have got too many employees. I can't add much more to that.

Thank you.

Mr. WALGREN. Well, I think that that may be more important from a testimony standpoint than almost any other finite observation that can be made. You, of course, see firsthand what the work force has experience and particularly in an area where certainly technical skills are required and yet your testimony fits hand in glove with the other gentleman's that it is not so much what is coming out of the schools that is being required at this point.

There are skilled people out there waiting and not finding. And to the degree that we do have pickup in our economy, they will find themselves as qualified as anyone and it is a difficult commentary on our time that it is so depressing in the sense of numbers, but I can think of nothing more real and nothing I would rather have in the record more than that kind of a statement about where the work force is today, particularly in this part of the country.

And I am not so sure that we are that different from other parts of the country. Other parts of the country have a smaller base from which to build, but those who have gone to look for work in those parts of the country have come back to Pittsbrugh saying that there isn't anything there that wasn't here.

So I really do appreciate your perspective on that. I think they lend a real undercoat of reality to this whole record.

I think that is a remarkable series of perspectives and statements. I was particularly interested in the idea of communication skills and those who were in here earlier, some of the other witnesses, particularly Father Lang from the Pittsburgh Diocese, was saying be sure that you think of the whole range of educational skills as you go riding off in the pursuit of science and mathematics.

I know one word you used in your testimony, Dr. Gottlieb, was the writing skills were "appalling."

Mr. GOTTLIEB. What is so shocking to me is that I see the very best. I don't see the average or the lower levels. I can only imagine what the level of skills is like in these large numbers of people who will somehow have to make their way in the work day world after they get out of school.

Mr. BERGHOLZ. I think the one thing that is interesting, however, and I think as in many previous instances what is happening in some school systems is kind of happening in advance of all of the expressed concern on the national level about the issue.

I am struck by the fact that in a few years I have sensed a real change in the Pittsburgh school system around that issue. My children are coming home with writing assignments now that I had hoped they would have had before. I think this represents a recognition in the community that these communication skills are at the heart of what this whole period of educational reform is about.

Mr. WALGREN. I guess that is a very basic skill and can only be taught with some appreciation for rigor and discipline in the sense of ideas and in the sense of the trend back to basics would help give you a platform from which to start that.

At the same time, it is a broadly based skill that can be developed in almost any specific discipline and carried from discipline to discipline and so almost any good educational program would build that skill.

Mr. GOTTLIEB. I think the reason that I have come down so hard on that particular issue is that especially within the past 2 or 3 years what I have come most to be impressed with as the overwhelming characteristic of our technological and economic system now is not just change but the rate of change, the body of information that a student comes out with even in engineering school today in 5 years may be entirely obsolete, and unless that student comes out with skills that are transferable, he is going to be lost.

To emphasize that just a little bit more, I can relate to you one phenomenon that is happening at the R&D Center now at Westinghouse. One of the divisions of Westinghouse that no longer exists is the lamp division. We don't make lamps anymore. There was an entire group at the R&D Center that was devoted to lamp research. These were Ph.D.-level people with a very high degree of skill, very, very intelligent and competent people.

All of a sudden that activity was stopped at Westingthouse. Those particular skills, at least, were no longer required. In order for those people today to arrive at the R&D Center they had to very, very quickly learn other things and how to do them.

Now, people who are narrowly trained without the flexibility of adapting to a rapidly changing environment are going to be very unhappy 10 years from now.

Mr. BERGHOLZ. I think, however, that this has to be viewed in the perspective of the issues that were raised at the other end of the table. What we have happening in terms of change is that a whole group of people who are coming out of the manufacturing side of things are now looking at a future that offers them jobs at minimum wage in nonskilled positions.

We are in the middle of change in the whole notion of education, it can put you into a middle-class future. We may be looking at a future that includes more jobs at MacDonald's than it does jobs at McDonnell-Douglas. That is another concern.

We have a vast group of people coming out of manufacturing who literally have no place to go in which they can maintain the standard of living to which they had become accustomed.

Mr. COLKER. The statistics show that service jobs are growing and manufacturing jobs are decreasing and that's something that we all know. Again, though, from the standpoint of the technical employee, of technically trained people, if the person is well trained in the very basic things without specialization, then the flexibility of retraining is much, much greater. We can take the employee as, Dr. Gottlieb said, and move him into another job if he really has a basic training. But if he just knows one thing and knows it by rote, he doesn't understand it, and then it's very, very difficult to retrain that employee.

So, that is why when we hire people we look at what the basic education is like. And, again, we say the same things that Dr. Gottlieb said. We look primarily for good skills in reading and writing and speaking. Those are the basics and they, as I said, are going to be more and more necessary as we work with computers, as we have to express ourselves exactly with the computer and get an exact message from it.

Mr. WALGREN. Well, we have several generations of people who were not given that signal by the society. The society wanted highly skilled manufacturing process people and now, as Mr. Swickline says, "We are replacing the part, we are not repairing it, and the manufacturing process and even the construction or assembly process has been so shortened by different work methods and different assembly methods that those jobs are just no longer there.

Mr. COLKER. But other jobs have been created, but the other jobs are of an intellectual nature. That is really the difference. We certainly have more people working with computers today than we had 10 years ago, and it's an enormous amount. And if you try to hire people trained in those disciplines, the people with experience in those disciplines, you find you have great difficulty.

We have people working in other disciplines that didn't exist 10 years ago. Those people are in great demand, so there is job growth.

Mr. GOTTLIEB. I think an example of that that I have come across even within our corporation is the following: A large amount of secretarial work, and maybe I shouldn't call it secretarial work, but dealing with manuscripts involves word processing. In my view, this is a skill that should be taught as typing should have been taught a few years ago in the high schools.

We find now, that there are relatively few secretaries who are willing to learn to do word processing in the offices now and that the people who tend to be most skilled are the ones who have gone through very recent training to acquaint them with the machinery and the techniques of word processing.

It seems to me that that is but an example of a generalized kind of skill that ought to be taught to practically everyone at the high school level and it wouldn't be all that difficult to do it.

Mr. WALGREN. Why do you think that they resist learning it?

Mr. GOTTLIEB. Resistance to change. I tnink it's exclusion and the expression of the narrowness of the education that they have in the past been exposed to. I think that they are ill-equipped to deal with change as perhaps most people are, those other ones that I happen to have come in contact with. But I think that that's merely a symptom of a larger overall disease, the resistance to change even when change is inevitable.

Mr. COLKER. But when you deal with something like word processing or any computer-based job, you are expecting the person to do something exactly. It has to be exactly right. It can't be almost right. It has to be exactly right, and I think that whether it's resistance to change or what I find, that when we try to introduce things like that to employees who have been doing things another way, many of them don't have the discipline of thinking that way. It's not that they can't remember the instructions, but they are not used to the logical thinking that is required to use the instructions on a word processor.

It's a completely different way of thinking. If you type in the normal way you make a mistake, you erase it, and you correct it. In the word processor, if you made a mistake you go through a certain set of instructions on your word processor. You get in the mode and you change it and you go on. You can't do it almost. You have to do it exactly. It's a different way of thinking and, again, I would disagree with Dr. Gottlieb.

I wouldn't want the person trained in the word processor when they come to us. I would want the person trained in basic reading, understanding. I would want the school to have taught the employee to do things in an exact way and really complete them, not almost complete them, and then I would say, OK, that person will be easy to train on the word processor.

We can send that person to a school that word processor manufacturer runs and in 1 week he will be able to run it. But a person who is used to not being exact in the way they think and not completing things properly, not finishing their assignment in school, will never learn word processing, and I think that it's the problem of attitudes and a problem in the way people do things.

Mr. WALGREN. Your business requires that you do it exactly. As I have seen the lenses they grind and that you must do it exactly or it won't work.

Mr. COLKER. There is only one right answer. Almost doesn't work.

Mr. WALGREN. Let me ask Mr. Bergholz. Do you think there is the ability to call forth a greater public funding for education? I gather that part of the public community, the mimeographed sheets and public awareness is really designed to sell the institution to the public so that the public will give effort back to the institution. We see in Utah they are saying: "Give me a tax increase," and in Utah, it is a very viable, political issue because of the sense of family in the Mormon culture and yet you really wonder when you deal with 14 percent of a community like Pittsburgh is there the ability through public relations to develop an appreciation for the need?

Mr. BERGHOLZ. It is not just a matter of public relations. I think public relations is used to bring some new people to the table and to begin to attract a different kind of leadership to the issue. I am struck by the fact that though the corporations didn't end up taxing themselves in California in order to improve the State financial situation for the public schools that the California roundtable was instrumental in leading a charge toward improving the school finance situation in that State and that roundtable is essentially the business leadership of the State and somehow their attention was attracted to the issue and they helped to put forward legislation that made for productive change.

You see that happening in the State of Washington and North Carolina where Jim Hunt the Govenor has put education on the State agenda.

I think that in Pennsylvania we would be hopeful of attracting the interest of the Business Council of Pennsylvania to that issue, but I am convinced that the involvement of the private sector as important as it may be to provide some funding, its real importance is in building a constituency that can lead to change.

Then another thought to Dr. Gottlieb. apparently Westinghouse runs an effort that does reach out, but you indicated that other companies could get involved in that and yet apparently there is still just Westinghouse.

Mr. GOTTLIEB. As far as I know, in this area, Westinghouse is the only one that does it. United States Steel, up until a few years ago, had a similar type of program at their research laboratory but for reasons that may be more or less obvious, they choose not to do it any more. Nevertheless, there are many, many technologically oriented industries in the Pittsburgh area that are staffed by people who could do this very well.

I might say, by the way, that in the few years that I have been operating the Westinghouse Research Development Institute, I have got a number of inquiries from different geographic areas around the country starting up similar programs. There are programs, for example, at locations where there are Government laboratories like Fermilab in Illinois. Any place where there is a concentration of technical people who have a possibility of doing this and it is already being done elsewhere in the country.

Mr. BERGHOLZ. One of the things that is going on here, and I believe you have a document describing some of it on a more limited scale, is that Westinghouse as well as Rockwell and Alcoa and PPG

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are all involved in an adopt-a-school program o[illegible] a smaller level. That is also providing some summer opportunities for a wide range of kids in schools that are adopted by these corporations.

Mr. GOTTLIEB. We have a feature of the Westinghouse to be given an examination at the end of it and we select the two top places in that examination and they are given summer internships at the R&D center and invariably they are exceedingly talented students. They have always been since we have been doing it and they turn out top quality work and that has been a very, very nice feature of our program and what I would like to see done is some mechanism for making internships available to high school faculty to kind of bring them in to an atmosphere where they can have their batteries recharged.

Mr. WALGREN. And yet your Westinghouse lecture is open to them and they don't come.

Mr. BERGHOLZ. But I think you have to put it in some perspective. It is awful easy to knock all the teachers. Clearly we have some problems there, but I see an awful lot of good things going on in classrooms. Most teachers who are not working a full 12 months are working 10 months and having to work somewhere else so the offering of nonpaying situations doesn't have the same appeal.

Mr. GOTTLIEB. I didn't say nonpaying. When I say internships, presumably that carries the possibility.

Mr. BERGHOLZ. You were mentioning the Saturday morning type of program. This is beginning to happen in Pittsburgh. There was a model started in Cleveland that provides a stipend for math and science teachers who go into corporations to do special individual work under the tutelage of somebody in the corporation.

Mr. GOTTLIEB. I think it is an excellent idea.

Mr. BERGHOLZ. We had five placements last summer and we will be happy to do more.

Mr. GOTTLIEB. I would be glad to see that expanded. It is an excellent idea.

Mr. WALGREN. Ms. Bach.

Ms. BACH. I have only one observation to make. I can remember in the late 1970's when I was teaching graduate school being criticized by my students in an undergraduate course for passing back papers with a failure for all these people who couldn't spell correctly and I was told at that time that spelling wasn't important; that phonetics, if they could sound it out, that was fine and I said that I hadn't taken that foreign language in a while and that if they wanted to pass my course they had to be able to spell and they were very irritated by it, but I can recall when I was going through school myself that the science majors were criticized highly for not being able to articulate properly, that they were too technical and I am sorry to say it sounds as if not only the science students may not have mastered the art of articulation, but now it seems that we have all brought ourselves or the students or the system has brought itself down a couple of notches and no one seems to have mastered very well the art of articulation.

That is really my closing observation.

Mr. WALGREN. You know communication skills, the thing that is most challenging about most jobs is that you are limited by your communication skills and you can see people succeeded. How diffi-

cult is it to remain the chosen person to lead a group of employees that is having such retrenchment but for tremendous communication skills? I know in my own situation the limits are really whether you can't communicate the way you want or you can always do it better. So certainly the educational system ought to be recognizing that and I certainly wish I could do it better. So it is a constant challenge.

But I do want to thank all of you on behalf of the committee for your time and your interest in this. I think we have some threads in here that are very interesting and good for our education and awareness here in a community like Pittsburgh of the problems we see and the progress that we are making and how far we have to go before this system really serves the people that we hope ultimately it will serve.

So thank you very much for your interest.

Mr. WALGREN. The last two witnesses, Dr. Lauren Resnick, the codirector, Learning Research and Development Center, University of Pittsburgh, and Dr. Julius Brown, Allegheny County Community College.

We were grouping people together. Let me ask the two of you to come forward and we will proceed.

Let's start out with Dr. Resnick and I understand that you have a time problem and I do apologize. These hearings have a way of taking a lot of time and that is my fault.

Please proceed.

STATEMENTS OF DR. LAUREN RESNICK, CODIRECTOR, LEARNING RESEARCH AND DEVELOPMENT CENTER, UNIVERSITY OF PITTSBURGH; AND DR. JULIUS R. BROWN, ALLEGHENY COUNTY COMMUNITY COLLEGE

Dr. RESNICK. That is all right. In fact, I enjoyed that preceding discussion enough that I am not terribly concerned even now about the time.

As you know, I am Dr. Lauren Resnick. I am a professor of psychology at the University of Pittsburgh and also codirector with my colleague Robert Glaser, who I believe testified before this committee about 2 years ago, of the Learning Research and Development Center.

Our center is a place in which experts from a number of fields come together to do fundamental research and applied work on the improvement of education and I will try to give you some flavor of that.

You have asked me to speak about the role of learning research in improving education and the particular role of our center in that effort.

I am going to speak about a type of research on learning that forms part of a new discipline that has become known as cognitive science. Cognitive scientists are drawn from varied disciplines including psychology, linguistics, computer science, and others as well and together they are investigating problems such as the nature of scientific and mathematical knowledge, the characteristics of expert problem solving in many domains, the ways in which people understand and produce written language. The ways in

which previously acquired knowledge and skill can influence the ability to learn.

To summarize, the large and growing body of cognitive research on learning is beyond the scope of the 10 or 15 minutes available here so let me just make three points that I think are crucial for today's discussion.

The first is that most of today's research unlike learning research of a decade ago and before is now concentrated on how specific subject matters and specific domains of skill and competence are learned. And so for the first time, virtually, we are developing a body of scientific knowledge about how mathematics is understood and learned, how science is learned, how people think as they write and in each discipline, in each subject matter in school, you might say. This kind of work is going on, in some areas more than others.

What that means is that this research on learning is much closer than past forms of learning research to being directly relevant to educational and job performance questions.

The second point is that cognitive scientists are concerned with the nature of high-level processes of reasoning and thinking in each of the fields that they study. We are beginning to develop a strong basis for education that will be not just in teaching of specific knowledge but in creating a citizenry able to learn and think on its own, a point that responds quite directly to the conversation at the end of the preceding panel.

The third point is that research is now beginning on the effects of different kinds of instruction on knowledge and on abilities to reason and learn and this means that the cognitive science research community is directly linking theory to educational practice rather than leaving that link to others.

The cumulative effect of all of this research has produced a relatively fundamental shift in our conceptions of learning. A recent article that I wrote, published in Science magazine, entitled "Mathematics and Science Learning, a New Conception," provides as good a summary as I am able to provide, so I call your attention to it.

In fact, it has already been read into the Congressional Record on May 3, 1983, by Congressman Brown of this subcommittee. But I have left you copies to make it easier to find.

What seems most useful for me to do now is to expand that discussion and to focus on how this new understanding of learning is beginning to provide a basis for improved education.

First of all, our research is on how people learn and understand mathematics and science. I stress mathematics and science because I was asked to; I quite agree with the concern for other forms of skill, especially in the communication areas and we work there as well. But this research in math and science, as an example, is providing a basis for more carefully and more usefully defining what it is that we want to teach. In other words, we have a much better way, or are developing a much better way, to be more accurate, of saying what it is that people really need to learn and how it is likely that they will learn it.

In addition to specifying objectives for education in more precise and useful ways, these cognitive analyses of mathematics and sci-

ence learning can also provide a basis for new and more useful forms of testing. This is especially true where we are concerned with problem solving and understanding in other than the routine skill performances that may so quickly be outdated.

This has been one of the hardest jobs in testing and it is a critical one for evaluating how our educational efforts are succeeding and for diagnosing the skill and knowledge of individual students during the educational process so that the instruction can be adapted as precisely as possible to their status and their abilities to learn.

Second, work on problem solving, reasoning, and how people study and learn from textbooks is providing more and more refined ideas about exactly what the differences are between people who learn easily and those who have more difficulty. This, in turn, is beginning to provide a basis for new ways of teaching that are showing some real promise in improving learning skills in those individuals who are potentially competent learners but who have not been doing well in school.

Third, research on how people understand what they read is providing guidelines for the rewriting of textbooks in science and in other disciplines as well so that they are more easily understandable and easier to learn from.

And finally, cognitive research is providing the knowledge we need to make deep educational use of the power of computers. Computers are, of course, extremely popular in education right now and are offered as virtually the panacea in some circles. However, most educational applications of computers are failing to use the real capacities of those machines.

Recent cognitive research is showing how computers of the kind that we can expect in schools within just a few years can be used as intelligent tutors that tailor presentations and requests for responses to the immediate status of the student. There is evidence that intelligent tutors of this kind can make very substantial differences in learning, for example, in certain parts of high school mathematics, and we are now beginning to build them for elementary school topics as well.

With that as a general statement of the field as a whole, let me focus for a moment on my own center's particular role in the field of cognitive science and instruction. Let me begin by noting that we are widely recognized as a leading institution in this field. This is reflected not only in our research program but also in a variety of activities that go on in our center. We edit a major journal in the field. Conferences are held regularly that attract scholars and practitioners from many parts of the country and the world. Visitors come from all over the world to work with us. That gives a flavor, but it is our specific research and development activities that bring all those people to us. And I think those are activities which you all know about.

I have given you a list of the titles of various projects that are now underway or recently completed just in the fields of mathematics, science, and technical skill learning. Each of these projects has been supported by funds from the Federal Government, either the National Science Foundation, the National Institute of Education, the Office of Naval Research, or in a growing number of

cases, some other armed service branch since the armed services have major educational concern for their recruits.

[The list mentioned above follows:]

Learning Research and Development Center

Mathematics, Science and Technology Skills Projects

Mathematics

Learning in Geometry (ONR)

Learning Algebra (ONR)

Concepts of Addition and Subtraction (NIE, NSF)

Teaching Computational Skill and Mathematical Understanding (NSF)

Problem Solving in Mathematics (NIE, NSF)

Learning Decimals and Fractions (NSF)

Teacher Knowledge of Math Curriculum (NIE)

Science

Expertise in Physics Problem Solving (ONR)

Development of Students' Knowledge of Mechanical Principles of Physics (NIE)

Micro-Computer Based Instruction Modules on the Laws of Motion (NIE)

Naive and Expert Theories in Elementary Physics (NIE)

Professional & Technical Skills

Expertise in Radiology (ONR)

Spatial Engineering/Interpretation of Engineering Drawings (ONR)

Problem Solving in Political Science (NIE)

Measurement of Proficiency in High Technology Tasks (AIR FORCE)

Problem Solving in Basic Electricity (NAVY)

Dr. RESNICK. As you can see just from scanning it, we are doing research on most of the major topics of the school mathematics curriculum, and on several important parts of the science curriculum. We are also extending our research to several kinds of technical skills that are called for in fields of work that may not require college degrees but do require highly trained technicians.

Some of the projects listed here are what one would call fundamental research; that is, work that is to uncover the nature of thinking and learning in the area studied. Other projects are directly concerned with new ways of teaching. For example, we have worked extensively on the problem of how to teach primary school arithmetic in a way that allows children both to learn to compute and to understand why computations work the way they do.

We have developed a series of computer-based lessons that seem to be a very effective way of doing this kind of teaching and that have been very well received in test schools and classrooms. In physics we work both on computer-based instruction, for example, a computerized laboratory that allows students to design and run experiments on the laws of motion and on ways of conducting classroom instruction so that students are forced to confront the misconceptions about physical science that they inevitably bring with them. That is somewhat documented in the list that you have.

This same interaction between fundamental research and instructional experimentation characterizes our work on professional and technical skills. A particularly interesting aspect of the work is our study of what teachers, especially elementary school teachers, understand of the content that they are teaching and how they use this knowledge while they are actually doing the teaching.

These studies will soon provide the basis for some new approaches to training teachers in mathematics and science, and perhaps other disciplines. To try out these training ideas, we will conduct summer training institutes for teachers and will also build some computer-based tutors for teachers.

Now, in describing this partial list of our center's activities I have already told you a good deal about how we disseminate our work, which was another of the subcommittee's questions. We consider it our task to move from the laboratory to actual trials of instructional ideas and to develop prototypes of the kinds of instructional materials that would be needed to support those ideas. So we develop and test instructional materials of various kinds ranging from handbooks for teachers to advanced computer programs.

We teach at training institutes and, perhaps most important in many ways, we give lectures and demonstrations both to educators and other researchers all over the country. What we don't do is try to disseminate our work directly to many schools; that is, other than to those schools with which we cooperate in the development and trials of our teaching and instructional prototypes. Instead we collaborate with other organizations, both public and private, whose main mission is to disseminate materials, techniques and ideas for improved teaching. Those can be schools of education and regional educational laboratories and so on; but particularly important, because of the influence they have and because they represent major infusions of private money, are the educational publishers of various kinds. We serve as general consultants in the design

of educational publishing programs and in that way bring to bear on those efforts the broad knowledge of instruction that we are developing at our center.

We also work with publishers as our various prototypes are ready for wider dissemination. We work with them to bring these programs and other materials into an attractive and economically feasible form for schools, and to market them throughout the country.

I would just like to close on one point that refers back to the preceding discussion. In addition to agreeing with the general tenor of the closing part of that discussion, that math and science and technical competence cannot be separated from general communication skills, I would like to stress that there is an agenda for mathematics and science education that is not tied to the job market. It is tied to the need for a citizenry that can live and make intelligent decisions in a society that is inevitably going to have to make hard decisions in which scientific and technical information is involved.

We have to think about educational programs in the science and mathematics area in those terms as well; and, although I haven't stressed it in this particular presentation, that is a very strong underlying aspect of what we do. And it is one of the reasons that, although we do some work in the development of professional and technical skills, we have chosen to concentrate our efforts on education at the elementary and secondary levels, for all of the learning population, not just the college bound and particularly gifted.

Thank you.

[The prepared statement, plus attachments, of Dr. Resnick follows:]

Testimony Presented by Lauren B. Resnick

before the

U.S. House of Representatives
Committee on Science and Technology,
Subcommittee on Science, Research, and Technology

Honorable Doug Walgren, Chairman

Pittsburgh Hearing on Science and Mathematics Education

(February 10, 1984--Pittsburgh, Pennsylvania)

Mr. Chairman, members of the Committee, I am Lauren B. Resnick, Co-Director of the Learning Research and Development Center (LRDC), and Professor of Psychology at the University of Pittsburgh. I have been asked to speak to you today about the role of learning research in improving education--especially in mathematics and science--and about LRDC's particular role in this research and improvement effort.

For citizens anxious to improve education as quickly as possible, it is not always clear what role research on learning can play. It is argued that if we trained teachers more thoroughly, devoted more in-school time to mathematics and science, and implemented tougher requirements and examination standards--all of which are things we already know how to do--then we could return America to its former high standards of educational achievement. However, when we reflect on the real nature of educational goals, it becomes apparent that we have inherited theories and practices that are inadequate to the educational tasks we now face.

The heart of the matter is that we are today trying to make it possible for almost everyone to meet standards of educational performance that once were expected of a much smaller segment of the population. We want to raise the levels of participation without sacrificing our traditional standards of excellence. This aspiration poses a complex new task for educators. In the not-so-distant past, many problems of education were solved by selection: If individuals did not learn with ease and study with enthusiasm, it was acceptable to drop them from the educational effort. Today, educators must solve these problems through instruction.

Although a relatively weak science of education was tolerable as long as we sought to teach only the willing and particularly able, we need better-developed knowledge of learning and teaching processes if we are to meet our new goal. To be maximally effective, educators--like other professionals--require a theory to guide them and tools to help them in

their work. They need the same kind of scientific foundation for their work as the biological sciences provide for the field of medicine and the physical sciences provide for engineering. Only with such a foundation can we proceed beyond what we now know how to do to the higher levels of educational performance to which we aspire.

The science of learning is the foundation for education. It is through research on learning that we can hope to provide the theory and tools that educators require. It is research toward the science of learning as a foundation for teaching to which I will address the remainder of my testimony. The research I will speak about is part of a new scientific discipline known as *cognitive science*. Cognitive scientists--drawn from such varied disciplines as psychology, linguistics, and computer science--are exploring in detail the processes involved in the acquisition of high levels of human capability. They are investigating problems such as the nature of scientific and mathematical knowledge, the characteristics of expert problem solving, the ways in which people understand and produce written language, and the ways in which previously acquired knowledge and skill can influence the ability to learn. In the past two or three years, the wider availability of powerful computers also has begun to create a community of researchers working on the implications of intelligent technology for instruction and learning.

Summarizing the large body of cognitive research on learning is beyond the scope of these brief remarks. However, there are three characteristics of current cognitive research that make it particularly relevant to education and thus to the concerns of this Committee.

First, contemporary cognitive research is largely concerned with how specific subject matters are learned. Instead of developing general principles of learning that often seem difficult to apply to particular branches of learning, cognitive scientists are studying the learning of particular branches of knowledge *directly*--and they are doing this in collaboration with experts in the fields being studied. We are thus, perhaps for the first time, developing a substantial body of scientific knowledge about how mathematics is understood and learned, and about how people think and learn in the individual sciences.

Second, cognitive scientists are interested in the nature of high-level processes of reasoning and thinking in the fields they study. Problem-solving abilities and critical thinking skills are at the heart of cognitive research. We are beginning to develop a healthy foundation for education that goes beyond the teaching of specific knowledge--that is, for education that can create a citizenry better able to learn and think on its own.

Third, researchers are beginning to study in detail the effects of different kinds of teaching on human competence. In the process, they are discovering more than ever before about the nature of learning itself. All of this means that we are *directly linking* cognitive theory to educational practice.

The cumulative findings from research of this kind have produced a fundamental shift in our conceptions of learning. I have described the substance of these emerging conceptions in an article published last Spring in *Science* magazine. The article, entitled "Mathematics and Science Learning: A New Conception," was read into the *Congressional Record* of May 3,

1983, by Congressman Brown of this Committee. Rather than attempt to recapitulate an already brief statement, I append a copy of the article here (attachment 1), and turn in my remarks to suggesting more precisely how cognitive research on learning is beginning to provide a basis for improved education. I will outline four areas in which we are already beginning to see changes based on cognitive research.

First, cognitive research on mathematics and science learning is providing an important basis for specifying in a more useful way than before exactly what it is that we should try to teach in these disciplines. It may seem odd to suggest that we need psychological research to arrive at a definition of what to teach in mathematics or science, yet that seems to be the case. What the cognitive scientist is able to discover is how people build up intuitive theories in mathematics and science--natural ways of understanding and learning in these subjects. Many natural intuitions are mathematically and scientifically sound--although they are often quite different in form from the intuitions that trained mathematicians and scientists develop. Other natural intuitions are mathematically and scientifically incorrect, but by studying them in detail we often discover that they are based on elements of correct knowledge. It is important for educators to know about both kinds of intuitions--those that are correct and those that are not--as they plan instruction. The correct intuitions can provide a basis for building new knowledge in students by starting with what the student already knows. The incorrect, but equally natural, intuitions also are important, for we must find ways either to block their development or to help students to confront and correct them.

Second, cognitive analyses of mathematics and science learning can provide the basis for new and more useful forms of testing, especially the testing of understanding and problem-solving skills. Comparisons of *expert* and *novice* understanding and performance suggest how we can distinguish more clearly between students who really understand a topic and students who are only repeating statements on which they have been drilled. Making this discrimination is one of the most difficult tasks that test designers face. Yet it is critical for evaluating how educational efforts are succeeding. Good tests also are needed to diagnose the knowledge of each student so that teaching can be tailored to the individual. An elegant example of diagnosis based on detailed cognitive analysis is a computer-based system that, using a child's performance on a small number of arithmetic examples, is able to decide precisely what misconception the child has about how to perform subtraction. With this diagnosis in hand, teachers can precisely target their teaching to the child.

Third, cognitive work on problem solving, reasoning, and how people study and learn from texts is providing refined ideas about exactly what the differences are between people who learn easily and those who don't. This, in turn, serves as a basis for new methods of teaching that are showing real promise in improving the learning skills of those students who are potentially competent learners but have not been doing well in school. For example, a recent research program has discovered methods of teaching children to question themselves and to monitor their own understanding as they read. This instruction has been shown to improve quite dramatically the reading comprehension of apparently backward middle school students. Research on how people understand what they read is also providing guidelines

for rewriting textbooks—in science and in other disciplines—so that texts are more understandable and easier to learn from.

Fourth, cognitive research is providing the knowledge we need to make significant use of the power of computers. Computers are, of course, very popular in education right now. However, most educational applications fail to use the real capabilities of the kinds of computers that we can expect to have in schools in the near future. The most common use of computers in schools today is for "drill and practice" on routine procedures and knowledge. This can be of substantial positive benefit. However, it does not really take advantage of what computers can do to adapt to individuals and to teach more complex and flexible kinds of thinking and problem solving.

Recent cognitive research is showing how computers can be used as *intelligent tutors*. Intelligent tutoring programs use a model of expert performance, along with a mini-model of the performance of the student who is working on the machine, to tailor presentations and requests for responses to the student's immediate status. Both the expert and the student models in these tutors are based on cognitive research on learning. There is evidence that intelligent tutors of this kind can make very major differences in learning subjects such as high school mathematics. The full potential for intelligent tutors in teaching school subjects is just beginning to be studied.

I have been describing the broad spectrum of cognitive research that is providing a scientific basis for education. This effort, and the development and testing which accompany it, is being conducted at research centers around the country. As is characteristic of all scientific research, cognitive research depends on active exchange and collaboration among a number of centers and laboratories. Within this network of scientific exchange, my own Center (LRDC) plays a central role. This role is reflected in a variety of activities, such as journal and book editing, conferences, and visiting scholar programs that mobilize and focus attention of scholars from throughout the nation and the world on questions relevant to education. Although these communication activities are important, it is our highly productive senior scientists and their specific research and development projects that attract the visitors and sustain the publication efforts. These are the activities that will be of most interest to this Committee. Let me describe some of them.

This list (attachment 2) shows the titles of a number of LRDC projects now underway or recently completed in the fields of mathematics and science learning. Each project has been supported by funds from the Federal government—either the National Science Foundation (NSF), the National Institute of Education (NIE), the Office of Naval Research (ONR), or another branch of the armed services. This list gives some sense of the range of what we are doing. A similar list could be provided for our work in reading, writing and other areas of the school curriculum. As you can see, we are doing research on most of the major topics of the school mathematics curriculum and on several important parts of the science curriculum. We also are extending our research on the nature of learning and expertise to the kinds of technical skills that are called for in fields of work that may not require college degrees, but do require highly trained technicians.

Some of the projects listed are fundamental research projects. Such projects aim to uncover the nature of thinking and learning in the area of study. Other projects are more applied. They are directly concerned with new ways of teaching--ways that are direct outgrowths of the theories of thinking and learning that we are developing. For example, we have worked extensively on the problem of how to teach primary school arithmetic in a way that allows children both to learn to compute and to understand why computations work as they do. Our work is showing that understanding why computations work is fundamental to being able to go on to the next levels of mathematics without undue difficulty. We have developed a series of computer-based lessons in primary school arithmetic that seem to be very effective in this kind of teaching and that have been very well received in test schools and classrooms.

In physics, we have worked both on computer-based instruction and on more effective forms of classroom instruction. For example, we have developed a computerized "laboratory" that allows students to design and run experiments on the laws of motion. We are also studying ways of bringing students to confront and correct their misconceptions about the laws of mechanics and motion. This work is based directly on our studies of how novices and experts in physics solve problems--the different kinds of knowledge they draw on and the different kinds of reasoning processes they use. The same interaction between fundamental research and instructional experimentation characterizes our work on professional and technical skills.

A special aspect of LRDC's work is research on what teachers--especially elementary school teachers--understand of the subject-matter they are teaching and how they use this knowledge *while* they are actually teaching. Just as we compare expert and novice physicists and technicians to arrive at an understanding of expertise in those fields, we compare expert and novice mathematics teachers to understand what it means to be an expert teacher in that subject. These studies will soon provide the basis for some new approaches to training mathematics and science teachers. To try out our ideas, we will conduct summer training institutes for teachers. We also plan to build some computer-based tutors for teachers.

In describing some of our research and development activities, I have already told you a great deal about how a Center such as LRDC disseminates its work. We consider it our task to move from the laboratory to actual trials of instructional ideas, and to develop prototypes of the instructional materials that are needed to support these ideas. Thus, we develop and test instructional materials--from handbooks for teachers to advanced computer programs. We run teacher training institutes, and we give lectures and demonstrations of our work to educators and other researchers all over the country.

We do not try to disseminate our work directly to schools, beyond those that cooperate with us in the development and trials of our instructional prototypes. Instead, we collaborate with other organizations, both public and private, whose major mission is to disseminate educational materials, techniques and ideas. Particularly important among these groups are the educational publishers. LRDC works very closely with several different publishers, both of traditional textbooks and of the newer computer-based instructional

programs. We serve them as general consultants in the design of educational publishing programs, thus bringing to bear on their efforts the broad knowledge of learning and instruction developed at our Center. We also work with publishers as our various prototypes become available for wider dissemination, to see that they are presented in an attractive and economically feasible form, and to market them throughout the country.

Through the interplay of cognitive research, development, and dissemination activities such as those conducted at LRDC, a rigorous scientific basis for learning and education is emerging. It is this foundation that can provide America with the resources needed to improve standards of educational achievement for our people. I am encouraged that those in attendance today recognize the urgency of our need in mathematics and in science, and in other subject areas as well. And I thank you, Mr. Chairman and members of the Committee, for holding this hearing and for providing me the opportunity to discuss the crucial role that learning research plays in our nation's effort to meet the great educational challenges we now face.

Lauren B. Resnick

Attachment 1

Mathematics and Science Learning: A New Conception

Lauren B. Resnick

Summary. Findings in cognitive science suggest new approaches to teaching in science and mathematics.

In the last few years a new consensus on the nature of learning has begun to emerge, stimulated by research in the field that has come to be known as cognitive science. The emerging conception of learning has a direct bearing on how science and mathematics can be taught most effectively.

I will sketch here a few examples of recent findings in cognitive science, many of which support the intuition of our most thoughtful teachers. In physics and other sciences, according to these studies, even students who do well on textbook problems often cannot apply the laws and formulas they have been drilled on to interpreting actual physical events. This observation has been made on all kinds of students, including gifted middle-school children and students at some of our most prestigious universities (*1, 2*). The inability to apply routines learned in school is consistent with recent findings from the National Assessment of Educational Progress showing that mathematical problem-solving skills of American children lag far behind their calculation abilities (*3*).

Another well-supported finding is that all students, the weak as well as the strong learners, come to their first science classes with surprisingly extensive theories about how the natural world works. They use these "naïve" theories to explain real world events before they have had any science instruction. Then, even after instruction in new concepts and scientifically supported theories, they still resort to their prior theories to solve any problems that vary from their textbook examples (*4–6*). Some studies have shown that students' prior theories can actually interfere with learning scientific concepts. The students' naïve theories affect what they perceive to be happening in classroom demonstrations or laboratory experiments, and they continue to attach their naïve meanings to technical terms (for example, the term acceleration).

Several studies show that successful problem-solving requires a substantial amount of qualitative reasoning (*7–9*). Good problem-solvers do not rush in to apply a formula or an equation. Instead, they try to understand the problem situation; they consider alternative representations and relations among the variables. Only when they are satisfied that they understand the situation and all the variables in it in a qualitative way do they start to apply the quantification that we often mistakenly identify as the essence of "real" science or mathematics.

These demonstrations of the potent role of naïve theories in science learning, and of the central role of qualitative understanding of a situation in problem-solving, contribute to a new conception of the learner and the learning process in mathematics and science. This research has in just a few years produced a new consensus on the nature of learning that is not yet widely reflected in the way mathematics and science teaching is conducted in the schools.

There are many complexities, but the fundamental view of the learner that is emerging can be expressed quite simply.

First, learners construct understanding. They do not simply mirror what they are told or what they read (*10, 11*). Learners look for meaning and will try to find regularity and order in the events of the world, even in the absence of complete information. This means that naïve theories will always be constructed as part of the learning process.

Second, to understand something is to know relationships. Human knowledge

The author is co-director of the Learning Research and Development Center and a professor of psychology at the University of Pittsburgh, Pennsylvania 15260. This article is adapted from an address at the National Conference on Precollege Education in Mathematics and Science, National Academy of Science and National Academy of Engineering, Washington, D.C., May 1982.

is stored in clusters and organized into schemata that people use both to interpret familiar situations and to reason about new ones. Bits of information isolated from these structures are forgotten or become inaccessible to memory.

Third, all learning depends on prior knowledge. Learners try to link new information to what they already know in order to interpret the new material in terms of established schemata. This is why students interpret science demonstrations in terms of their naive theories and why they hold onto their naive theories for so long. The scientific theories that children are being taught in school often cannot compete as reference points for new learning because they are presented quickly and abstractly and so remain unorganized and unconnected to past experience.

What does this new understanding of the learner suggest about how we can improve mathematics and science education? First, it is never too soon to start. From their earliest years, children are developing theories about how the world works. There is reason to believe that naive theories will not take hold so firmly if scientific theories become available to them early. Furthermore, it is becoming clear that it takes a long time, and many different examples, for understanding to develop. It is not reasonable to postpone the beginning of this process to a high school or college course.

Second, teaching has to focus on the qualitative aspects of scientific and mathematical problem situations. Too quick an advance to formulas and procedures will not help children acquire the kinds of analytical and representational skills they need. Extensive qualitative analysis is not common in science or mathematics teaching. It may seem to take too much classroom time, and many teachers are perhaps too inexperienced in these ways of thinking. But the new evidence about learning makes it clear that we cannot avoid taking on this task.

A focus on qualitative analysis and understanding of situations does not mean a retreat from the teaching of computational procedures or scientific formulas, or from the basic factual information in any discipline. There is definitely an important role for the traditional skills of mathematics and science and the facts that underlie them. But the procedures and formulas must be treated as matters that make sense, and children must be involved in the task of making sense of them. Research has not yet told us whether it is better to first become skillful at a procedure and then analyze it, or to allow procedures to grow out of understanding a situation. But research has made it clear that procedures must take on meaning and make sense or they are unlikely to be used in any situation that is at all different from the exact ones in which they were taught.

Finally, since naive theories are inevitable, teachers will probably have to confront them directly. Students may have to be forced to pit their theories against the ones they are being asked to learn, to deal with conflict between theories in much the way that scientists do. This, too, is a new challenge, for only rarely today does teaching explicitly acknowledge children's prior theories (except to mark them wrong) or even recognize the difficult intellectual work entailed in giving them up or substantially revising them.

Research in cognitive science is not only changing our views of how people learn science and mathematics but is also shaping a theory of learning in which the content of what is learned plays a central role. In the past, it has often been difficult for mathematicians and scientists to find in the work done by psychologists and other behavioral scientists much that seemed directly relevant to the problems of teaching their disciplines. The general principles that psychologists produced seemed too far removed from the specific questions of curriculum content that concerned the scientists and mathematicians. That has changed.

A critical theme of the past several years of work in cognitive science has been that a person's intelligent performance is not a matter of disembodied "processes of thinking" but depends intimately on the kind of knowledge that the person has about the particular situation in question. This has led cognitive scientists to recognize that in order to understand complex learning they must study how people learn particular subject matters. As a result, there are now cognitive scientists actively engaged in studying mathematics learning in particular, physics learning in particular, and so forth. At the same time, mathematicians and physical and biological scientists have begun to study the cognitive processes involved in learning their disciplines, often in direct collaboration with psychologists.

This kind of collaboration has been significantly invigorated by grant programs of the National Institute of Education and the now disbanded Science Education Directorate of the National Science Foundation, but these collaborative links are still fragile. In times of retrenchment it is easy to return to traditional alliances and the familiarity of one's own discipline. To keep the collaboration alive, we must give careful attention to supporting vigorous programs of cognitive research in mathematics and science learning. If this is done, the educational payoffs are likely to be large and not unduly long in coming.

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Lauren B. Resnick
Attachment 2

Learning Research and Development Center

Mathematics, Science and Technology Skills Projects

Mathematics

Learning in Geometry (ONR)

Learning Algebra (ONR)

Concepts of Addition and Subtraction (NIE, NSF)

Teaching Computational Skill and Mathematical Understanding (NSF)

Problem Solving in Mathematics (NIE, NSF)

Learning Decimals and Fractions (NSF)

Teacher Knowledge of Math Curriculum (NIE)

Science

Expertise in Physics Problem Solving (ONR)

Development of Students' Knowledge of Mechanical Principles of Physics (NIE)

Micro-Computer Based Instruction Modules on the Laws of Motion (NIE)

Naive and Expert Theories in Elementary Physics (NIE)

Professional & Technical Skills

Expertise in Radiology (ONR)

Spatial Engineering/Interpretation of Engineering Drawings (ONR)

Problem Solving in Political Science (NIE)

Measurement of Proficiency in High Technology Tasks (AIR FORCE)

Problem Solving in Basic Electricity (NAVY)

Mr. WALGREN. Thank you very much.

Let me just ask if we can focus on what must lie at the heart of the learning process and recognize that the steps that the learning involves, do you expect that that knowledge will change our way of going about it very dramatically in the next 10 years?

Dr. RESNICK. It could. This is, as I have tried to convey, a relatively new area of research. It is booming, but it is new and the accumulation, while impressive when you make a list, hasn't yet begun to really fully come together. That is, the different pieces of scientific work still need to be joined and there needs to be a lot more work. There are important hints that some quite fundamentally different ways, say of teaching elementary school mathematics, might be much more viable, but I am not ready to say so yet and think that it would be wise for others to wait just a little bit. If we are able to make important contributions to bit-by-bit improvement, we are not waiting until the whole story is in until we begin to work on the immediate needs. On the other hand, a major reorganization is a big thing to ask, and until we have very strong evidence that there are importantly better ways to do things, we are going to be cautious. But there are interesting things that are happening that could point in those directions.

Mr. WALGREN. Is the National Science Foundation playing a central role in stimulating this area?

Dr. RESNICK. It is, again, as a result of the fiscal 1983, to a small extent, and especially the fiscal 1984 budget increase which went to funding for the science education directorate. You will find at the end of the science article a call for help in that very area. I don't speak causally, but it does look like that call is being heeded as a result of so many people's concern for mathematics and science education.

Yes, I think the National Science Foundation's role is crucial, and I hope that it will continue to be supported both in the science education directorate and, as is now being done with much smaller amounts of money, in some of the other branches of social science and behavioral science research where work relevant to science and mathematics learning is also being done.

Mr. WALGREN. Are they exercising reasonably good judgment in what to fund and what not to fund?

Dr. RESNICK. Well, I don't have any complaints yet, and I hope not to. On the other hand, we haven't yet seen. We have essentially come from zero funding a year and a half ago for this kind of research to somewhere between 55 and 67 million depending on what you add in, and those decisions are just now being made. In fact they are just now receiving proposals. It takes a whole lot of effort to build back up a constituency of research and development people when there has been a lacuna in the funding. So we are going to have to see, but they have high quality staff and everything looks right.

Mr. WALGREN. All right. Ms. Bach, do you have any questions?

Ms. BACH. No.

Mr. WALGREN. Thank you very much. We appreciate the contact with you and knowing that we can find you again as this whole area develops, and we'll try to work with it. Thank you very much, Dr. Resnick.

Dr. RESNICK. Absolutely. Thank you very much. I do have to leave, and I apologize to my colleague for that.

Mr. WALGREN. Then we will turn to Dr. Brown of Allegheny County Community College, accompanied by Dr. John Sabol.

Welcome to the committee. We are glad you are here. Please proceed with some comments and guidance that you think we should have.

Dr. BROWN. Thank you very much.

The community college of Allegheny County and community colleges nationally are deeply grateful to the Subcommittee on Science, Research and Technology and to the subcommittee's chairman, you, Representative Walgren, for the recognition given to the role of community colleges in addressing the Nation's high technology technician training needs as presented in House bill 1310, Emergency Mathematics and Science Education and Jobs Act.

I will provide a general overview on the community college's role in the struggle to enhance the county's math and science capabilities. Dr. John Sabol's testimony will follow and emphasize specific math and science programs at our college and list local industry's cooperative efforts.

The community college continues its commitment to a comprehensive educational mission providing both liberal arts transfer programming and short-term occupational training for those citizens hoping to enter the job market as quickly as possible. We see high quality math and science instruction as completely necessary for both career paths. Conversely, we must meet the enormous two-prong challenge of "basic illiteracy" and "technological illiteracy" which abounds in this city, this State, and across the Nation. So such data has been produced on the unfortunately large number of functional illiterates in America that it's a well-recognized problem.

A similar difficult problem is exhibited in the fact that most Americans are not technically literate or oriented. There is a distinct shying away from math and science whether it's in the youth or adult population. This tendency must be reversed if our citizens of today and tomorrow are to compete successfully in an increasingly hightech world.

The mission of community colleges has been expanded dramatically and the illiteracy problem magnified because of the demand for worker retraining. Many persons in the Pittsburgh labor market area, and in other areas of Pennsylvania, historically have been able to have relatively high earning power without possessing basic computation, science, and communication competencies; however, with the structural changes occurring in the economy of this great industrial center, these persons, and a large number of them are in their 40's and 50's, must now acquire those basic competencies to be productively employed in new and emerging occupations during the remainder of their working years.

The community college of Allegheny County has what I believe to be an impressive list of local industry linkages designed to prepare and move students into the jobs of the future. However, it's not enough, and our hope is to multiply our efforts.

The community college of Allegheny County, and the Allegheny campus in particular, has as a top priority the acceleration and ex-

pansion of its educational services to address the extensive worker illiteracy that faces this economy as we seek to retain our national and international acclaim as an industrial center.

We see the community college playing a crucial role in preparing future employees according to employer needs. To achieve this goal, we must recognize and solve four critical problems:

One, as training institutions, community colleges must have the necessary funding to expand instructional support programs which combat student illiteracy. Programs of this type, tutorials, learning centers, interactive libraries, exist at CCAC, but not in the quantity necessary. We know how to get the job done, but lack the resources.

Two, currently, financial aid programs do not fund developmental courses which are necessary to combat both forms of illiteracy. I refer to developmental courses specifically designed and sequenced to provide basic competence for advance instruction. The practice of eliminating legitimate developmental courses discourage students from taking these needed classes.

Three, with the actual explosion of new technologies, community colleges need additional funding to keep equipment and instruction up to date. We cannot help prepare students for present and future jobs by providing training on obsolete equipment.

Four, if funding can be secured to purchase state-of-the-art equipment, adequate general and laboratory space must be available to accommodate it. It's a practical concern which could stymie our efforts if not addressed.

In concluding this overview, I'm sure that I have not exhausted the issues, but I hope that these comments have provided an insight to the commitments and problems community colleges have as we struggle against the two illiteracies and prepare our citizens for a high tech world.

Dr. John Sabol's more specific comments and answers to the subcommittee's questions will now be presented.

[The prepared statement of Dr. Brown follows:]

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CCAC

Two Forms of Illiteracy and the Demands of High Tech Employment

Testimony before the House Subcommittee on Science, Research, and Technology, U.S. House of Representatives

by

Dr. Julius R. Brown, Vice President and Executive Dean
Dr. John Sabol, Assistant Academic Dean
Allegheny Campus, Community College of Allegheny County
Pittsburgh, Pennsylvania 15222

President, Dr. John W. Kraft

February 10, 1984

The Community College of Allegheny County, and community colleges nationally, are deeply grateful to the Subcommittee on Science, Research and Technology, and to the Subcommittee's Chairman, Representative Doug Walgren, for the recognition given to the role community colleges have to play in addressing the Nation's high-technology technician training needs as presented in H.R. 1310, Emergency Mathematics and Science Education and Jobs Act.

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successfully in an increasingly high tech world.

Because of the long-standing commitment of community colleges to open admissions, the Community College of Allegheny County and other community colleges have had to address the varying degrees of inadequacies in both types of illiteracy.

The mission of community colleges has been expanded dramatically and the illiteracy problem magnified because of the demand for worker retraining. Many persons in the Pittsburgh Labor Market Area, and in other areas of Pennsylvania, historically have been able to have relatively high earning power without possessing basic computation, science, and communication competencies; however, with the structural changes occurring in the economy of this great industrial center, these persons, and a large number of them are in their 40's and 50's, must now acquire those basic competencies to be productively employed in new and emerging occupations during the remainder of their working years.

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We see the community college playing a crucial role in preparing future employees according to employer needs. To achieve this goal, we must recognize and solve four critical problems:

1. As training institutions, community colleges must have the necessary funding to expand instructional support programs which combat student illiteracy. Programs of this type, tutorials, learning centers, interactive libraries, exist at CCAC, but not in the quanity necessary. We know how to get the job done, but lack the resources.

2. Currently, financial aid programs do not fund developmental courses which are necessary to combat both forms of illiteracy. I refer to developmental courses specifically designed and sequenced to provide basic competence for advance instruction. The practice of eliminating legitimate developmental courses discourage students from taking these needed classes.

3. With the actual explosion of new technologies, community colleges need additional funding to keep equipment and instruction up-to-date. We cannot help prepare students for present and future jobs by providing training on obsolete equipment.

4. If funding can be secured to purchase "state-of-the-art" equipment, adequate general and laboratory space must be available to accommodate it. Its a practical concern which could stymie our efforts if not addressed.

In concluding this overview, I'm sure that I have not exhausted the issues, but I hope that these comments have provided an insight to the commitments and problems community colleges have as we struggle against the two illiteracies and prepare our citizens for a high tech world.

Dr. John Sabol's more specific comments and answers to the Sub-Committee's questions will now be presented.

Dr. Julius R. Brown,
Vice President and Executive Dean
CCAC - Allegheny Campus
February 10, 1984

Specifics on CCAC's Role in

Science/Math/High Tech. Education

In order to address the pre-college needs of students in science and mathematics CCCAC instituted a developmental program shortly after opening its doors to its first students. The developmental program covers the areas commonly known as the three "R's" namely reading, writting, and mathematics, The numbers of students involved in this program is quite large. As an example, a recent study we made for the Fall 1981 Term out of 1,239 entering students at Allegheny Campus 48.4% entered at the lowest level and 27.1% at the upper developmental level. Together we see 75% requiring remedial work. The lower level in mathematics is a basic course in arithmetic and the second level is a first course in basic algebra. Theses numbers can be further amplified by another example at Allegheny Campus. Currently we are running a total of 110 sections of developmental mathematics with an average of eighteen students per section. This includes both day and evening with the bulk during the day. Students in the developmental program are limited to twelve credits which precludes them from getting "into any college level science course." Additionaly we offer a basic electricity course which is a pre college level but is not considered a developmental course. It is not uncommon to have students entering at the developmental level take three or four years or more to complete a two-year associate degree program. The figures I quoted earlier were based on Allegheny Campus, however, they also match, very closely, the experence of the other three campuses. In addition to the developmental courses offering and in support of the same we have a Learning Center which has a tutoring service and a Basic Skills program to work with the learning disabled and the subdevelopmental students. Currently we are getting no external support for the Basic Skills program.

The above also addresses the problems we encounter with high school students coming to take courses in science, mathematics and technology programs. It is not limited, however, to high school students but also those people 20 years old or older returning for upgrading, retraining, or getting a late start. As was pointed out earlier we offer a basic electricity course but besides that also basic chemistry, basic physics, and basic biology courses. These are not the normal first year college science courses which presupposes some basic background and understanding.

On the other end of the scale the students with the necessary background and preparation that enter the college level science and mathematics courses do very will along with those that have successfully completed our developmental program. We also find the number of students coming directly into the science and mathematics course is higher than it was several years ago. This may be due to the depressed economy of the local area. As an example we ran two Calculus I courses, on Calculus II, and one Calculus III with the latter having about ten students several years ago at Allegheny Campus. Currently we are running six Calculus I, four Calculus II and two Calculus III courses. These same numbers will spill over into the sciences.

The College is in dire need of additional monetary support not only in operational funds but also in capital funds. Our needs could be reduced somewhat if we didn't need to have the extensive developmental program, however, given the current number entering at this level it would take a few years to change this aspect. Thus, given the current status we need more teachers. At Allegheny Campus alone we could hire six additional full-time mathematics faculty and give them full loads and probably still need some part-time help in the day program alone.

The budget is too lean to allow this. Again, what is true at Allegheny follows for the other campuses. Mathematics is used as an example but this also holds true for data processing and all the sciences. Money is needed not only for people but also for state of the art equipment, supplies, and facilities. We couldn't open a new laboratory even if we had the manpower and equipment because we have no place to put it. We are, for example, currently renting classroom space from the Y.M.C.A. at Allegheny Campus. College Center North has nothing but rented facilities to use. For the most part the manpower is available in the market place to staff our needs but the shortage is in the means to accomplish the same. Even when we obtain federal and state grant funding we need a 30% match. We have no other sources and the avilability of state and/or federal money is minimal.

Specifically, relative to capital funds for high technology programs, the needs are considerable. Over the past several years we have not received any capital fund budget severely hampering out science programs. As a result equipment breakdowns were not replaced and that which could was patched up and kept in service with a prayer. This what capital funds that are presently being allocated are being used to replace worn out equipment to keep the ongoing programs effective. Again using Allegheny Campus as an example, Capital Budget requests made by the departments totalled $1,134,288 the amount allocated was $350,000 which is one quarter of what is needed. This year the requests total $1,108,658. I suspect some of the departments gave up on trying. At any rate, I expect the allocation to be about the same as last year. We are playing a catch-up game. Without a firm committment of resourses, namely dollars, we can't hope to develop and run the programs necessary to educate and train people in the new emerging technologies. Engineering is a good example.

CAD/CAM equipment to train draftsmen and engineers in the usage and application of state of the art equipment costs about $50,000 for a set up that can be used for five students maximum. Computerized Numeric Control devices for modern day tool machining cost $90,000.00. An Electronic Distance Measuring Device used in surveying costs $10,000.00 per unit. It is needless to point out various automation devices used in conjunction with microprocessors are extremely expensive. New high technology is wide spread from sophisticated analysing devices in hospitals to word processors in today's offices. All of these programs need to be upgraded with state of the art equipment. Minicomputers and Microprocessors are at the heart of all high technology. Everything in high tech. evolves from the "chip".

We need to obtain a wide variety of minicomputers and the ancillary software since they all have their individual specialties and pecularities. The equipment, however, is not enough with out the manpower and the facilities which compounds the costs. There are a number of high technology programs that are necessary to upgrade our work force and the Community College is ready to develop them if the finds were available to support them. The following is a list of some that we have identified:

1. Laser Optics Technician
2. Telecommunications Technician
3. Biomedical Technician
4. Computerized Numeric Control Machining Tool Technician
5. Pneumatic Laboratory Technician
6. Radiology Technician
7. Surgical Technician
8. T.V. Production Technician

There are many others besides the few addressed here as examples. Robotics alone must include operators, maintenance people, computer programmers, electronics specialists, microprocessor specialists, mechanics, and pheumatics specialists. All of the above have a high cost price tag.

The only way the Community College can hope to fulfill its mission to meet industries' demands in training a high technology work force is with substantial monetary assistance. As an additional note to point out the needs to enhance our offerings, we are currently being funded with some additional operating funds to retrain displaced workers from this area, the number involved is quite sizeable. There has not, however, been any additional capital money for more laboratories and equipment. CCAC, for example, provides training and retraining through four principal components:

1. Two-year associate degree programs: Programs in such fields as welding technology, applied electronics, and diagnostic medical sonography, that are designed to make a student competitive in the job market.

2. Apprenticeship programs: Programs designed in cooperation with labor unions, management, and government, to give the student the necessary skills and education to receive Journeyman's papers and an associate degree. Programs have been developed in the construction trades and machinist technology.

3. Customized job training: Specific non-credit training programs designed in cooperation with a private company.

4. Upgrading: Non-credit programs designed for private companies to upgrade the technical skills of particular groups of workers.

Specifically a listing of programs offered at CCAC that relate to high technology in varying degrees follows:

Nuclear Quality Assurance
Energy Technician
Chemistry
Chemical Technician
Medical Laboratory Technologist
Histology Technician
Radiation Therapist
Radiation Therapy Technician
Engineering Technology
Mechanical Design and Drafting
Structural Design and Drafting
Scientific Data Processing
Electronics Technology
Microprocessor Technology
Data Processing Specialist
Computer Electronics

Engineering Physics
Engineering Science
Industrial Engineering Technology
Microcomputer Electronics
Science and Engineering Technology
Digital Electronics
Micro Computer Technology
Diagnostic Medical Sonography

Nuclear Power Technology
Physics/Nuclear Power Plant Technology
Electro-Mechanical Technology
Combustion Technology
Automative Technology

In addition to the above we offer transfer programs with the first two years for majors in Engineering, Mathematics, Physics, Chemistry, and Biology. Generally all programs are designed to meet students' needs for employability and can range from several courses to a one year certificate or two year associate degree. Currently a pilot program has been developed in Robotics to retrain displaced workers with some minimal background in electro-mechanical repair. These people will be trained in approximately eight months for employment as Robotics Repair Technicians. We hope to develop this into a two year program for people with little or no previous background.

At this point in time our local industries are not geared for high technology for the most part. This is one of the reasons for their gradual demise. The need is to generate new high technology industries in this area and to upgrade those which are adaptable. The land, building, and equipment is not enough without the knowledgeable people to operate them. This is where the Community College fits into the picture. This is our business, to educate and train but we need the resources and cooperation to do the educating and training and we also need industries to employ them. Without the latter we are merely doing an exercise in futility. The people trained in high technology will, obviously, go to the locations where jobs exist. Employment training programs, no matter how well designed and carried out, mean little without the availability of jobs.

The first priority in the Pittsburgh region today remains the creation of new employment opportunities, and it is critical that any effort to improve the training and delivery system recognize this fundamental fact. Additionally, training programs in the region continue to be handicapped by a lack of knowledge of how the labor market has functioned in the past, and where the jobs are likely to be in the future. A better forecast of regional job opportunities, drawing on the expertise and knowledge of the private sector, is an indispensable prerequisite to a sophisticated, effective employment training system.

Our interface with local industries is not as extensive as we would like it to be. In the cases where some industries have high technology state-of-the-art equipment they are reluctant to get involved with cooperative ventures in training students. One of the reasons for the reluctance is due to the high cost of the equipment involved and the fear it could be damaged when exposed to untrained hands. Another problem is the fear that students will replace unionized workers for less money. We do however have some interface with our Cooperative Program option. This is a program that allows a student to get on-the-job experience and ear anywhere from six to twelve credits and also earn some money. Some of our COOPs are listed here:

Nuclear Power Tech. - Westinghouse
Micro-Computers - Bureau of Mines
Energy Technology - Bureau of Mines
General Science - Bureau of Mines
State-of-the-art Auto Mechanics - General Motors
Combustion Technology - U.S. Steel
Electronics - U.S. Steel
Microprocessors - Duquesne Light
Advanced instrument courses - Coopers
CAD/CAM - Westinghouse
Electronics Technician - U.S. Weather Bureau

The one area where we place most of the cooperative students is in data processing. The companies involved over the years are listed below:

Alcoa
Alcoa Building Products
Mellon Bank
City of Pittsburgh
County of Allegheny
Consolidation Coal Company
N.A.P.C.O. Inc.
Allegheny General Hospital
University Health Center
Pittsburgh Des Moines Steel Company
Hussey Metals
Joseph Horne Co.
Pittsburgh National Bank
National Draeger
Ryan Homes
Harbick & Held
Vector Group
U.S. Dept. of Energy
U.S. Corps of Engineers
J.C. Penney Co.
Pittsburgh Board of Education
Giant Eagle Super Markets
St. Francis Hospital
Oliver Realty
Kay-Jay Data Science
Management Science Associates
Mobay Chemical Corp.
Eastern Association Coal Corp.
Gooding Rubber Co.
Process Corporation
Milton Meyer Inc.
Gulf Research
Process Corporation
Milton Meyer Inc.
Gulf Research
Honeywell
University of Pittsburgh
Armour Company
Project Memory

The robotics program mentioned earlier is another example of college/ industry cooperation. Westinghouse donated several robots along with their robotics engineer chairing the advisory committee th assist in the technical course development. A combination of steelworkers, executives from Westinghouse and D'Appalonia are assisting in the planning and design of a Factory Automation Institute.

Many of our evening part-time instructors also come from the local industries. A number of local business and industry men and women sit on our advisory committees. As was pointed out earlier, high technology in local industrial firms is at a minimum. We therefore do not have a large market for graduates in high technology locally. We do have a placement office and counselor who works closely with all local businesses and industries identifying their needs and recommending graduates to fill them. In many instances students that are involved in the cooperative program end up being hired by that firm.

In conclusion it can be said that in education, business/industry and political communities the buzz word is high technology. Although high technology will cut across all the service areas of vocational/technical education, it is normally post-secondary institutions which are expected to deliver. This required education can not be a warmed-over high school vocational education program, a modified pre-engineering program or a pre-anything. It can not be a cut-and-paste series of patchwork courses. It is expected to be a highly developed curriculum with articulation capabilities and providing job potential, it requires considerable time, effort, and funds. The net result is that many institutions are responding slowly and carefully to the role they must play to support the work force in the high tech market place.

In one sense, community colleges have always responded to technological innovation. Their strong tradition of responsive career programs has caused them to review curriculum continually, to consult advisory groups and to introduce needed adaptions in curriculums and equipment. But today's task is even more complex. Change is no longer gradual and it is seldom permanent.

Obviously, the need to develop high equipment cost programs in an atmosphere of retrenching dollar or, as community colleges have experienced over the past several years, no equipment dollars, seems to be a risky venture at best. It will, therefore, be necessary to find the necessary funding to support and encourage these types of high tech. Finally during the last 30 years, Pennsylvania lost over 300,000 jobs within the manufacturing industries. Between 1970 and 1980, an estimated 435,000 persons moved to other states because of limited jobs in Pennsylvania.

Committed to economic development, the government has been willing to pay more attention to those factors which will aid in the recovery. Community colleges have, and will continue to play a key role in this recovery. We recognize that the challenge and the responsibilities are not solely ours. But we do recognize that we must experience expanded efforts in the form of support and funding to ensure the future strength of our economy and the vitality of our educational system. Unless we can all flourish, we will all decline.

Mr. WALGREN. Thank you, Dr. Brown. Dr. Sabol.

Dr. SABOL. I thank you for the opportunity to be here and present some of my perceptions on the community college and in terms of math and science and other things.

I might just give you very briefly my own background. I started out as a high school teacher in science and mathematics quite a few years back. I won't tell you how many. Then subsequently at the time that the community college opened its doors I came aboard, and I like to call it from day one, and at that time as a mathematics professor and along the line I have been able to work my way up to my current position as assistant dean in the areas of aviation, business, mathematics, and engineering. And it is quite extensive.

From the previous testimony I heard here earlier—I only came in about 1 o'clock so I didn't hear too much. I didn't hear the elementary and secondary people, but from the people I did hear it kind of makes me feel good because it pretty much corroborates some of the points we had made in the testimony that you have and somewhat reinforced it, too.

Essentially what we covered in the written testimony that you have there, are some perceptions on the quality of students that we are experiencing and some of the problems that we see there. Also, in terms of high tech programs, essentially what kinds of programs that we offer currently that could fit into that category. Also, a mention of some of the ones that we would like to be able to offer but can't simply because the resources aren't there, and the big resource being funding, for the most part.

Also, we have addressed to a degree what our interactions are with industry, what kinds of things currently exist at this time, what we would like to see happen and what we think needs to happen in that respect, especially as we look to what the key focus is here, on science and mathematics education and retraining in terms of high tech and training specifically for high tech.

Underlying all of this, and you will see that thread running throughout our testimony, is the concept of needing funds and resources this is a threat we will find all the way through there.

The other point I would also make is that the community college is flexible. It is able to adapt and adjust almost instantly. We are working continually in developing curriculum programs, et cetera, as needed. And we have a good track record of doing that over the past and we can continue to do that. And I think we are in a good position where we can come to meet the task of whatever needs to be done beyond what we are already doing in training for high tech.

And along that line, also the fact that we do have some programs in faculty development, however, I think again certainly not totally adequate. I think a lot more can be done in that respect, especially in terms of upgrading due to new technology and that kind of thing.

Quite early in our history when we opened our doors for the first time we discovered that there was really a very distinct need for additional training for the incoming students. A very high percentage of our students coming to us were inadequately prepared for the first year of college work. I talk about first year college work, and I mean that which we normally think a freshman coming into college would normally take, a college algebra and trig and something like that, a first-year physics course, et cetera. Consequently, we had to put together a developmental program that really begins with the seventh grade level.

Now, even going down that low it doesn't reach that level. Sadly enough there are people coming into the college that are below that level, especially in reading; and of course we are talking about low level skills in reading. The three R's, reading, writing, and arithmetic.

To give you an idea of what the figures are, we have essentially two levels of developmental work. A very low level and then the slightly higher level of developmental work. Of those two levels—these are all precollege now. Out of that level, we are talking of incoming students, 70 percent are in some phase of developmental programs, taking some developmental courses. Seventy percent of the developmental students are coming in at that level. There are two levels, and that is spread out over the two levels and, additionally, and this is not unique in this area but from the literature that I read and conferences that I attend, attrition rates for students at this level is roughly about 40 percent, and that is pretty much the national figure. So it is not unusual although we are constantly bothered by it and continually investigating and trying new methods and trying to lower that as much as possible.

Now, the obvious fact is, from those figures, is that those incoming people, the bulk of them, are not ready for a college level math or science course. As a matter of fact, over the years we have devel-

oped in the sciences some basic courses, even though we don't call them developmental courses. We have a basic electricity, a basic chemistry, and a basic physics, and essentially there would be the same kinds of, or same levels of, science courses we find in the high school curricula certainly, not really the college level.

And also to further point out, the 70-percent level that I am talking about, just this spring term I sat down and counted across the board only in mathematics—and when I talk about mathematics, the two levels, the first level is arithmetic, simple arithmetic, basic computations; the second level is a first course in the fundamentals of algebra.

Over those two, we are currently offering this spring term 110 sections. Now that averages about 18 people per section. Now I am talking about 110 sections. That is day, evening, in the centers spread across the country.

Now I am only talking about Allegheny campus. However, you will find a similar situation at all campuses. When I use Allegheny campus as an example, it is not unique. That is essentially true at south campus, at Boyce campus, and college center north.

There is a little bright side. On the bright side, we are experiencing at this point in time a greater number of students coming in that are better prepared, that are coming in to higher level classes.

We used to have to struggle to offer a calculus 3 course. We'd get about 10 students eventually in calculus 3. We are now running a couple of sections of calculus 3 and having them filled. Calculus 1 we ran one or two sections. We are running up around six sections now and so forth.

Now, probably my speculation is that the reason that we are getting a greater number of better qualified students, higher level students, is simply because of the depressed economy in the area. For simply economic reasons, more people are coming to the community college.

However, that is unfortunate, because I feel we can, regardless of whether it is cheaper or not—and of course they think of it as being cheaper, but they forget that they are only paying one-third of the tuition. The county covers a third, and the State covers a third, so the tuition is really three times what the students see, but many of them don't realize that.

Mr. WALGREN. You say that 75 percent, I guess, at that point are entering in some form of developmental program and that is these two levels?

Dr. SABOL. That is right, 70 percent.

Mr. WALGREN. And you say you get no external support for that basic skills developmental program?

Dr. SABOL. No; as a matter of fact, we have a learning center. In the learning center of course the various ancilliary services we offer are tutoring, and the audiovisual, and the basic skills program.

The basic skills program dips down below and brings people up to at least that lower developmental level, and I think it was last year that we lost what money we were getting externally and we had to scratch around and try to find some money to keep the program going.

Mr. WALGREN. Where did that money that you lost come from?

Dr. SABOL. That was a Federal grant of some sort, I think, that was administered through the State vocational education program.

Dr. BROWN. Yes, sir; it was vocational education programs.

I think even a more crucial concern is that currently financial aid programs will not cover developmental courses and you have the dichotomy of students needing developmental courses to be raised to a level of competency that they can take math and science instruction, yet financial aid programs will not fund those particular courses within an individual's schedule.

Mr. O'NEILL. I just had a question following up on the concept of the developmental students. Do you have any way of measuring, or do you have any intention of measuring, how far up you bring them? That is, do you administer some type of measurement testing at the end of the developmental course?

Dr. SABOL. Over the past years it has been difficult to get any money to institute a good research department. We are getting now some backup in research, and we are starting up some programs now.

As a matter of fact, we have a Middle States accreditation evaluation coming up this spring, and we have written a Middle States report on that. We have related some of the problems we have and also some of the studies that we are intending to do, and we are starting to get some support. However, it is not external, it is internal support, internal moneys that are running that.

Dr. BROWN. There are some practical educational areas that we have been successful in.

Students who come in, let's say, at a 10th grade level, might go through to developmental semesters, and then they take the first year college level instruction and they go on to nursing programs and other demanding programs. The only reason we feel they are able to do that is because they have had the developmental instruction prior.

Mr. O'NEILL. Just as a general observation, it seems that if we strengthen the base of the pyramid, so to speak, if we really shore up the elementary and secondary math and science education programs, then you folks would not be drained of perhaps the resources that could be spent on buying new scientific instruments to keep you up to date.

Dr. SABOL. True, but that certainly can't be done overnight.

Mr. O'NEILL. I understand that.

Dr. BROWN. For those who are above 19 who are already in the above population, we still have that obligation. We would be delighted if, on the elementary and secondary level, we could be getting better products, but we still have to deal with those in the adult population.

Mr. WALGREN. It also seems inconsistent for the Federal Government, as I understand it, to be heavily involved in the remedial education in the regular secondary school system and have specific programs to teach exactly what you are then having to go back and pick up without any external help at all, and apparently our Federal educational aid does not reach that age level; is that correct?

Dr. BROWN. It probably is, in my estimation. Adult basic education is generally seen as something that happens in the elementary and secondary schools, and we really have no problem with that,

but there are members of the adult population who elect to come to the community college, many, such as in the Pittsburgh area, who have not attended school in the last 10 to 15 years, yet they have to be retrained for productive lives, and I am saying that an unemployed person who meets financial aid guidelines cannot take remedial or development courses and those be funded by financial aid programs.

Mr. WALGREN. And these are high school graduates, are they not, that are coming in?

Dr. BROWN. In most cases they are high school graduates. Some are not.

Dr. SABOL. Some are the GED. They either are high school graduates or have the GED equivalence of a high school graduate.

Mr. WALGREN. I was looking through the rest of your testimony, Dr. Sabol, and I can see that—see the need for capital funds, how tight the budgets are in that area.

Dr. SABOL. Very definitely, and as I pointed out last year, we felt it on the campus bequests, from the department were $1 million and some odd dollars. I don't have the exact figures, but I think we were able to get about $350,000.

Now, prior to that, we hadn't even gotten that. There were no capital funds at all. We were very lean. So we are at a point right now where we are trying to catch up and replace worn out equipment and we are not even thinking about the state of the art yet.

Take CADCAM for example. We want to get for some engineering and drafting and so forth. A piece of Bausch and Lomb equipment costs $50,000, which, at the most, you could service five students at a time at the most, and that is not really good. Ideally, two students.

That gives you an idea of the cost of moving into high tech, and there are a number of programs that we'd like to get into, and I listed a few of them there in high tech.

Of course, again you are talking about very expensive equipment. Now this is another reason why, as I pointed out, that in some cases where local industries do have some equipment, they are not too anxious, in fact, are reluctant, to make any kind of cooperative arrangements with us simply because it costs a lot for the high tech equipment and they are afraid we are going to damage it.

Mr. WALGREN. So there are limits to some of our hopes for private industry creating truly integrated training programs?

Dr. SABOL. I would like to see something like that. There are areas in the State and across the country where this is happening. I have been in a few conferences where IBM, for example, down in Texas, maybe one or a few of the high tech outfits in Texas and southern California that are actually working very closely with community colleges, and the colleges are really doing customized training using, for the most part, the laboratory facilities at the industry.

So it is being done, and I think it is a matter of getting together, and I think this is one of the things we need to do, is get together with some kind of group made up of educators and representatives from industry and work out some cooperative arrangements.

I heard one gentleman testifying earlier which disturbed me a

little bit. He mentioned universities and technical schools, and I don't think he knew that the community colleges existed. That bothered me a little bit.

And emphasizing the fact that they are doing their own training, we have the experts, we have a high quality faculty, we have the know-how, the wherewithal, insofar as training and education is concerned, and I think working together we could do a tremendous job.

I guess the other thing also we need in the area is, we need somewhere for these people to go once they get out and just to train them in high tech, so what? Where are you going to get a job? We have got to have the industry here too, the job here.

And one more point, if you will allow me. The other deficiency that I see is that there really is no good data and information on job market analyses. Not only the present situation, what is needed presently, but in terms of long range down the road, 5 years down the road or 10 years down the road.

Of course that kind of data is very important. It helps us to move and adapt to the needs of the community, which is, after all, what we are all about. We are supposed to serve the community.

Mr. BROWN. I'd like to make one additional statement, if I could. We are in the process of developing a robotics repair program. We are currently training 23 people who probably or possibly could have come from the industry that one of the other witnesses mentioned. They do have basically electrical or electronic experience. These people are actually getting hands-on instruction on the repair and the maintenance of robotic equipment.

We are fortunate, and it is one of the examples of cooperation between industry and the college. Westinghouse provided us with three robots, and we are actually in the process of training our people on installation, maintenance, trouble-shooting, and repair of robotic equipment. Out of those 23 students, I believe 4 of them have already gotten jobs. They have not actually completed the program yet, because we feel that industry really does not exactly know how they are going to use the new technology.

So as we prepare these people who were broadly trained in this new area, we feel that they will be leaders within various companies in terms of new manufacturing processes and that kind of thing.

I want to make one other statement too that I think is indicative of our training philosophy. An earlier witness or witnesses disagreed on whether they would train people for word processing.

We feel that a generic approach for training people for word processing is appropriate. There are probably between 25 to 30 different vendors and different types of word processing machines. It is almost impossible to train people for a specific machine.

We think it is important though that our students are trained on two or three representative types of machines, and in a laboratory setting have the ability and experience of transferring that knowledge from one machine to another in this field that prepares them best for going into industry. Our experience is that that is true.

So it is those kinds of training job-oriented experiences that we are going through constantly, and we think our instruction is geared to that.

Mr. WALGREN. Well, your written testimony will be made a part

of the record. If I didn't say that at the outset, I certainly appreciate your having participated with us. We do appreciate the depth of that need in the technical area in particular. We wish there were ways that we could be more responsive to it in terms of really providing the resources, but we will work on it.

Ms. Bach, anything further?

Ms. BACH. Just the one question. I was curious what it would cost per course on an average basis from the developmental program that you have.

Dr. BROWN. It is basically a liberal arts type course. There is no extensive amount of equipment needed, just a classroom and basic materials.

Dr. SABOL. Other than essentially the teaching part of it, yes, you have the instructor and the classroom, so I mentioned in math you are talking 110 sections there, and in reading and in the writting you can almost duplicate that number of sections.

Dr. BROWN. What would be the cost of an average class?

Dr. SABOL. That is difficult to say. In math they are generally the equivalent of four credit course. A single instructor would teach 16 credits, so that is four courses. Divide 4 into 110, you are getting roughly 27 or 28 instructors just to teach 110 math courses.

Plus, I guess if you wanted to really make a good cost factor, you would have to include the portion of that that goes to overhead for facilities and so forth, plus beyond that then the other support services, the tutors, the learning center with the audiovisual aids. But there are no other kinds of equipment other than that.

Ms. BACH. When a student comes into a community college, do they pay a flat rate, or don't you charge them per course?

Dr. SABOL. A credit; it is $33 a credit.

Ms. BACH. So the development program would not be $33 a credit.

Dr. SABOL. $396 for a full load generally for 12 to 18 credits.

Ms. BACH. If they have any development program or course in their curriculum, does that exclude them from financial aid for anything that is not developmental?

Dr. BROWN. No. The courses that are excluded are specifically the developmental courses. If they take regular college level sociology or whatever, then that is funded through financial aid. It is specifically the developmental courses that are excluded.

Dr. SABOL. They are considered zero credit. They are not college credit courses.

The only exception to that is, we have actually three associate degrees, associate in science, associate in art, and a third degree which is the associate in applied science. Now that degree allows a student to use one developmental course in each area as a fulfillment of the requirements for the degree. That means they could use one reading, one English writing, and one math course.

The point I was making there is, that is the only kind of quasi credit given to those developmental courses, but essentially they are zero college credit classes.

Ms. BACH. Is it a financial institution that determines whether one of your courses is a developmental course versus a full credit college level course?

Mr. SABOL. What was the question again?

Mr. O'NEILL. Basically, who determines—is it the lending institution or the community college that determines whether a course is really fundamental or not or whether it is a college level course?

Dr. SABOL. The institution determines that. Essentially, in the beginning we started with what we perceived as we looked around at all the colleges and any community colleges when we put our first curriculum together, what was first year math, what is first year English, and first year language, and so forth.

Once we experienced our first class, we said, a lot of these people aren't ready to function at this level, so we dropped down one level and instituted a new course lower than that, which basically is the same level that is being taught or geared to be taught at the secondary level.

So essentially that is what makes it developmental, what is essentially the same kind of material that would be in a course at the secondary level. So you are talking about a first course in algebra. Algebra 1 it is called in high school. We call it fundamentals of algebra.

Dr. BROWN. An expansion of that is that the Federal Government would look at what is the transferability of your courses. That would be the central factor. Is it equal to what you would get in a first year from the other school.

Mr. SABOL. Your middle states accrediting agencies—you are accredited education for the kinds of college credits that you have, therefore another accredited school would accept your credits because they have been verified by the association.

Mr. WALGREN. Thank you very much on behalf of the committee. We appreciate it.

Mr. BROWN. Thank you very much.

[Whereupon, at 4:20 p.m., the subcommittee adjourned.]

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